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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 15878, 15880, and 16359.

15828 (AD–642344) RARE EARTH FRACTIONATION IN HAWAIIAN VOLCANIC ROCKS. Schilling, Jean-Guy (Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics). Aug. 1966. Contract Nonr-1841(74). 395p. (DSR–8841). CFSTI $3.00 cy, $0.65 mn.

The procedure for determination of the rare earth elements and yttrium utilizing tracer-monitored group separation, neutron activation, and carrier-free partition chromatography developed by Volfovsky et al. (1963) was revised and improved. Using this improved procedure, rare earth and yttrium abundances were measured in twenty Hawaiian lavas of known chemical and mineralogical composition, one peridotite inclusion from Salt Lake Crater, Oahu, and one olivine-rich nodule and its host 1801 basalt flow from Hualalai, Hawaii, and a diabase from Oahu. When comparing the rare earths, element by element, in the twenty lavas, to a low potassium olivine tholeiite, four distinct groupings were observed. The origin and genetic relationships of these different groups are discussed in the light of their rare earth patterns, mineral patterns from other localities, experimental petrology, theoretical and geochemical reasoning. Possible processes operative in the formation of these lavas, such as fractional crystallization, partial melting, fractional melting, limestone syntexis, and fractional resorption are explored. The origin of the ultramafic inclusions is also briefly discussed. (ATD)

15829 (AERE-R-5310) THE APPLICATION OF ISOTOPE DILUTION MASS SPECTROMETRY TO BURN-UP DETERMINATION. PART I. URANIUM. Foster, E.; Fudge, A. J.; Steele, C. L. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1967. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 5s. 6d.

Isotopic dilution, coupled with mass spectrometric analysis, has a number of important advantages over other techniques when applied to uranium for determination of burnup. Both the experimental and the theoretical aspects of this technique are considered for the analysis of samples of irradiated potential nuclear fuels, and results by this method compared with those obtained by other methods. Limitations of the isotopic dilution method due to inaccuracies in the nuclear data and to contamination from uranium are discussed. A computer programme, which enables the mass of uranium in the sample and the burnup to be calculated from the isotopic ratios resulting from mass spectrometric measurements, is included. (auth)

15830 (ANL–7229) CONSTRUCTION OF A GLOVEBOX THERMOGRAVIMETRIC ANALYSIS APPARATUS; LANGMUIR AND KNUDSEN EXPERIMENTS ON THE EVAPORATION OF Gd_2O_3 FROM 2140 TO 2600°K. Messier, Donald R. (Argonne National Lab., Ill.). Nov. 1966. Contract W-31-109-eng-38. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An apparatus for high-temperature thermogravimetric analysis, consisting of a resistance furnace and recording microbalance, was constructed in a glovebox for eventual work with plutonium ceramics. The system was tested in vacuo for leaks, furnace control, and pyrometer calibration at furnace temperatures up to 2673°K. Langmuir and Knudsen evaporation experiments were made with gadolinium sesquioxide in the temperature range from 2140 to 2600°K. Two sets of data obtained with the Knudsen cell yielded an average value of $\Delta H_T^\circ = 464.0 \pm 1.0$ kcal/mole for the assumed evaporation reaction $Gd_2O_3(s) = 2GdO(g) + O(g)$. Enthalpy calculations based on the second and third laws of thermodynamics resulted in good agreement. The experimental results indicate that the evaporation coefficient may be much less than one. (auth)

15831 (COO–256–65) APPLICATIONS OF RADIOISOTOPES IN POLAROGRAPHY. Progress Report. Mattes, Fred; Schaap, W. B. (Indiana Univ. Foundation, Bloomington. Research Div.). [nd]. Contract AT(11-1)-256. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method using radioisotopes in polarography was developed to study anomalous electrode reactions and to apply them to the analysis of dilute aqueous and nonaqueous solutions. In radio-trace polarography the observed radioactivity of a collected mercury sample at each applied potential is plotted vs. the applied potential. Cell designs are described. (M.C.G.)

15832 (DP-MS–66–41) PRECISE DETERMINATION OF OXYGEN IN CURIUM OXIDE BY INERT GAS FUSION–GAS CHROMATOGRAPHY. Doherty, P. E. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 9, 1966. Contract AT(07-2)-1. 9p. (CONF-660933–3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

Inert gas fusion–gas chromatography is shown to be a very precise, rapid method for determining the total oxygen content of a wide variety of compounds including curium oxide. The method was used as a primary means of determining the stoichiometry of these compounds. (auth)

15833 (DPSPU–66–30–8) SRP INTERMEDIATE-LEVEL ANALYTICAL CELL FACILITY. Lethco, A. J.; Davies, M. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sept. 1966. Contract AT(07-2)-1. 15p. (CONF-660933–4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

To meet analytical requirements while maintaining safe and expeditious handling of samples, a versatile analytical laboratory and hot cell facility was designed and constructed. The 25- by 50-ft facility was installed within the existing laboratory. It consists of two intermediate-level analytical chemistry cells interconnected with a sample receiving area, an analytical laboratory, and a decontamination area. Two unusual features of the material handling system are an electrically driven rotating transfer port and battery-powered cart conveyors operating within exhausted equipment. The overall design of the facility provides continuous containment of contamination during all transfers to and from the cells and within the analytical laboratory from receipt of sample to completion of analysis. The floor plan and sample flow are illustrated. (P.C.H.)

15834 (TRG-Report–1382) MEASUREMENT OF Kr AND Xe FISSION PRODUCT RETENTION IN IRRADIATED FUEL ELEMENTS. Jennison, W.; Clark, M. L. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Nov. 30, 1966. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 2s. 6d.

Fission gases retained in mixed oxide and carbide irradiated fuel specimens were measured. Samples weighing between 1 and 3 g are dissolved in acid under reflux, helium is passed through the apparatus, and the liberated fission gases are dried and trapped in activated charcoal at the temperature of liquid nitrogen. Gases other than krypton and xenon are almost entirely re-

moved by distillation from the cold trap. The gas fraction containing Kr and Xe is collected and measured by an automatic Toepler system. An aliquot of this fraction is analyzed by mass spectrometry and the measured krypton and xenon can be related to the weight of fuel dissolved, as determined by chemical analysis and mass spectrometry. (auth)

15835 (UCID-15066) ANALYTICAL SECTION QUARTERLY REPORT, JULY 1-SEPTEMBER 30, 1966. [Harrar, Jack] (ed.) (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 30, 1966. Contract W-7405-eng-48. 41p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in analytical equipment and methods and in direct determinations are reported. The methods include improvements in atomic absorption and flame emission, spectrophotofluorimetry, x-ray fluorescence, and cathodic etching. Modifications are described for special purpose gas chromatographs, inlet system for high sensitivity gas chromatograph, coincident field cycloid mass spectrometer, field operational differential mass spectrometer, helium densitometer, vacuum fusion equipment, and controlled-potential coulometer. Determinations include: Hf in Mo-Hf nitride alloys; Pb in Pb glass; trace W in Ag; trace Cl in fluoroelastomers; low-level Si in V-Si and Fe-Si alloys; trace fluorides in refractory alloys and metals; Hf in W; rare earth impurities in La; metallic impurities in W, Ta, and Mo; impurities in Re; trace impurities in gases; He diffusion rates; LiOH in LiH; C and S in refractory metals. The homogeneous precipitation of beryllium hydroxide, use of multichannel pulse height analyzer with electron microprobe; standards preparation line; primary pressure standards line; and cathodic etching to prepare metals for oxygen determination are also discussed. (P.C.H.)

15836 (UCID-15079) ANALYTICAL SECTION QUARTERLY REPORT, OCTOBER 1-DECEMBER 31, 1966. Harrar, J. E. (comp. and ed.) (California Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in the design of new equipment, methods, and actual determinations are reported. The equipment and methods include: atomic absorption spectrophotometry; automatic helium analyzer; mass spectrometer; x-ray fluorescence; spectroscopy; controlled-potential coulometer; vacuum fusion apparatus; gas chromatographs; and inlet system for gas chromatography. The determinations include: light elements in uranium compounds; helium diffusion rates; metallic impurities in W, Ta, and Mo; trace W in Ag; Mo in W; impurities in Re; Hf in W; trace fluorides in refractory metals and alloys; trace U in Ag; Ag in $AgNO_3$; Hf in Mo-Hf and Re-Hf alloys; Hf in W-Hf alloys; impurities in EDTA; Be in filtrates; and C and S in refractory metals. (P.C.H.)

15837 (UCRL-17166) QUANTITATIVE ANALYSIS OF URANIUM AND THORIUM SOLUTIONS WITH A SEMICONDUCTOR X-RAY EMISSION SPECTROMETER. Klecka, Jack F.; Hyde, Earl K. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 3, 1966. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The feasibility of rapid analysis of uranium- or thorium-containing solutions by x-ray emission spectroscopy using a silicon semiconductor detector is discussed. The 60.2-day ^{125}I was used as the primary source of radiation for excitation of the L x rays of thorium or uranium. The observed count rates with $L\alpha$ peaks for the various concentrations are given. The curve was linear within the counting statistics below a concentration of ~2.6 mg/ml. Below a concentration of 0.1 mg/ml the ratio of L x-ray count to background became too small to give dependable results without a great increase in counting time. Above 2.6 mg/ml the curve bent over because of self absorption of uranium or thorium L x rays in the solutions. The attempt to analyze mixed solutions of thorium and uranium was not promising because of the closeness in energy of the x rays. (M.C.G.)

15838 (Y-KG-37) ANALYSIS OF ALUMINUM ALLOYS BY ATOMIC ABSORPTION. Dill, M. S. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 1, 1967. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study was undertaken to find out whether atomic analysis could be applied to aluminum alloys without sacrificing accuracy and precision obtainable by wet chemistry. Determinations of Cu, Mg, Fe, Zn, Cr, Pb, Ni, and Mn were made on Alloy Type 87A. Results were consistent with wet-chemistry methods. (P.C.S.)

15839 HAZARDS TO ^{131}I ESTIMATION IN THIMEROSAL PRESERVED MILK. Howe, J. R.; Lloyd, M. K. (Central Veterinary Lab., Surrey, Eng.). Health Phys., 13: 414-15 (Apr. 1967).

Thimerosal (sodium ethylmercurithiosalicylate) was suggested as an effective preservative for milk samples intended for ^{131}I or ^{90}Y analyses. It was claimed that this substance has an advantage over formaldehyde in that it does not affect the state of iodide ^{131}I and therefore allows the use of ion-exchange methods of analysis. Studies suggest drawbacks to the use of this preservative. When iodide ^{131}I was added to thimerosal-preserved milk part of the radioiodine was converted to a form that did not occur in control milks without thimerosal, and this form was taken up by polythene, rubber, and cream in amounts that increased with time and concentration. Similar results were observed in simple aqueous solutions of thimerosal containing iodide ^{131}I. Apart from these considerations, there is a consequent failure to remove all the ^{131}I by anion-exchange resins. It was concluded that thimerosal is not suitable as a preservative for milk for ^{131}I monitoring. It was found that sodium metabisulphite is a suitable preservative. (UK)

15840 MICROANALYSIS OF INCLUSIONS IN IRRADIATED UO_2. Jeffery, B. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater., 22: 33-40(1967).

An electron-probe microanalyzer was used to examine inclusions present in highly irradiated uranium dioxide. Segregation of solid fission products was observed and usually found to be associated with the inclusions. Molybdenum and/or barium were detected as the main constituents together with other fission products such as rhodium, ruthenium, technetium, cerium, neodymium, strontium, and zirconium. The UO_2 matrix was also examined and found to contain zirconium plus lanthanum, cerium, praseodymium, and neodymium. (auth)

15841 THE ANALYTICAL USE OF THE FLUORESCENCE OF THE FOUR-LIGAND β-DIKETONE COMPLEXES OF EUROPIUM AND SAMARIUM WITH ORGANIC BASES. Melent'eva, E. V.; Poleuktov, N. S.; Kononenko, L. I. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 22: 187-92(Feb. 1967). (In Russian).

Conditions were found for the fluorimetric determination of europium and samarium by means of their four-ligand complexes with thenoyltrifluoroacetone and organic bases (collidine and diphenylguanidine). The determination can be carried out by measuring the fluorescence of the precipitation suspension or of the complex solutions in organic solvents. The sensitivity of the first modification of the method was 0.0005 to 0.0001% of Eu_2O_3 and 0.005 to 0.001% of Sm_2O_3 in Gd, La, Tb, Y, Yb, and Lu oxides; the method was less sensitive in the presence of other rare earth elements. If the determination was carried out by measuring the fluorescence of benzene extracts the sensitivity was 0.001 to 0.0005% of Eu_2O_3 and 0.05 to 0.02% of Sm_2O_3 irrespective of the base element. (auth)

15842 COMPLEXONOMETRIC DETERMINATION OF TETRAVALENT PLUTONIUM USING XYLENOL ORANGE AS AN INDICATOR. Nemodruk, A. A.; Glukhova, L. P. Zh. Anal. Khim., 22: 193-5(Feb. 1967). (In Russian).

The possibility was studied of determining plutonium(IV) by its titration in acid solutions (0.1 to 0.25M HNO_3 or HCl) using Xylenol Orange as an indicator. Plutonium(IV) can be determined in the presence of 1250 times its amount of uranium(VI) and in the presence of large amounts of Ca, Al, La, Ni, Cr(III), Pb. Iron(III) does not interfere if its amount in the titrated solution is not more than 3% from that of plutonium (IV). (auth)

15843 PHOTOMETRIC DETERMINATION OF SCANDIUM IN THE PRESENCE OF RARE EARTH ELEMENTS BY MEANS OF LUMOGALLION. Akhmedli, M. K.; Gambarov, D. G. (Kirov Azerbaidzhan State Univ., Baku). Zh. Anal. Khim., 22: 276-8 (Feb. 1967). (In Russian).

Conditions for complex formation of scandium with lumogallion (5-chloro-3-[2,4-dihydroxyphenyl)azo]-2-hydroxybenzenesulfonic acid) were studied, the complex composition (1:1) and the molar extinction coefficients at 530nm (10,200 ± 200) and 500nm (1400 ± 360) were determined. A method for the determination of scandium in the presence of rare earth elements was suggested. (auth)

15844 A LIQUID-SCINTILLATION TECHNIQUE FOR THE RADIOASSAY OF ^{45}Ca. Hardcastle, J. E.; Hannapel, R. J.; Fuller, W. H. (Univ. of Arizona, Tucson). Int. J. Appl. Radiat. Isotop., 18: 193-9(Mar. 1967). (COO-947-7).

A method for radiocalcium assay by liquid scintillation was developed. The method has the advantages of being quick, precise, versatile, and having a high detection efficiency for ^{45}Ca. The method consists of converting calcium salts to the chlorides, bringing the sample to volume, taking a sample aliquot to dryness at 130°C in a 20-ml sample vial, adding 15 ml of a dibutyl phosphate:toluene mixture (containing primary and secondary fluors), shaking until all the calcium salts are dissolved, and then counting the solutions at -5°C. Under these conditions 500 mg of $CaCl_2$ can be accommodated in the 15 ml of fluor reagent, and ^{45}Ca assayed with a precision of 0.15% and a high absolute detection efficiency of about 85%. This method is applicable for ^{45}Ca assay in common agricultural materials. (auth)

15845 DETECTION OF FREE FLUORINE IN THE ATMOSPHERE BY ^{131}I RADIOTRACER ANALYSIS. Eggebraaten, V. L.; Miller, L. E. (Boeing Co., Seattle). Int. J. Appl. Radiat. Isotop., 18: 183-91(Mar. 1967).

The chemical displacement reaction, $F_2 + 2I^- \rightarrow I_2 + 2F^-$, was evaluated as a means of detecting and measuring free fluorine in the atmosphere. The objectives were to study this reaction at micro-concentration levels, to develop the calibration techniques that will produce a working analytical procedure, and to predict the potential use of this system as a compact, portable type instrument for performing atmospheric determinations on field locations. The basic experimentation involved passing the atmospheric gases through alkali iodide columns tagged with radioactive ^{131}I, which is released and captured in a sodium thiosulfate solution on exposure to calibrated quantities of fluorine contamination. Determining amounts of fluorine in ppB quantities, instantaneous recording of the atmospheric contamination, discriminating between elemental and combined fluorine, and instrument portability are the favorable features sought with this technique. (auth)

15846 INSTRUMENTAL RADIOACTIVATION ANALYSIS OF SELENIUM IN BIOLOGICAL MATERIALS. Dickson, R. C.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Int. J. Appl. Radiat. Isotop., 18: 153-9(Mar. 1967).

A correction procedure was established for the instrumental radioactivation determination of selenium in dialyzed biological materials, by means of the 19-sec isotope ^{77m}Se. Based on the oxygen content of the samples, the procedure enabled a more accurate and sensitive determination than previous methods utilizing ^{77m}Se for determination of selenium in such a matrix. The production of ^{19}O activity ($T_{\frac{1}{2}}$ = 29 sec.) has hitherto limited the accuracy and sensitivity of the technique. The amounts of selenium bound to protein in various fractions of human blood and other tissues were investigated using the technique. (auth)

15847 DETERMINATION OF THE O–U RATIOS IN SUPERSTOICHIOMETRIC UO_{2+x}. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Nukleonik, 8: 366-72(Sept. 1966). (In German).

The O/U ratio in UO_{2+x} was determined. The method was based on the fact that the UO_{2+x}-phase is reduced to UO_2 by graphite at temperatures above 900°C with simultaneous formation of CO_2. The reaction mixture is heated in a stream of dry argon and the formed CO_2 is continuously measured by coulometric analysis; from these results the O/U ratio can be calculated. The completeness of the reduction is confirmed by x-ray diffraction. Moreover the possible influence of the Boudouard reaction on the results of O/U determination is discussed in detail. It was concluded that the coulometric method is not only valid for the accurate determination of the O/U ratio but that it is also useful for the production of stoichiometric uranium carbides by the oxides process. By this method the x value for the UO_{2+x} phase can be determined for values of x between $0 \leq x \leq 0.33$ with a standard deviation of about ±0.001. (auth)

15848 THE REACTION OF URANYL IONS WITH 4-(2-PYRIDYLAZO)RESORCINOL. Sommer, L.; Ivanov, V. M.; Novotna, H. (Purkyne-Univ., Brno). Talanta, 14: 329-43(Mar. 1967).

The uranyl ion and 4-(2-pyridylazo)resorcinol (PAR) form only 1:1 chelates in solutions of pH < 8.5; $UO_2(PAR)H^+$ is formed at pH > 3 and $UO_2(PAR)$ at pH > 5.5. Equilibrium constants and spectrophotometric data for both chelates are given. Solid, nonstoichiometric crystalline species in which the mole ratio of PAR to uranium is more than 1:1 are precipitated up to pH 6. The medium of 0.1–0.2M triethanolamine at pH 8, recommended by other workers, proved satisfactory for the sensitive spectrophotometric determination of uranium, as did pH 3.6 in the presence of <0.1M formate or 20 to 30 vol % dimethylformamide. (auth)

15849 DETERMINATION OF ALUMINUM AND SODIUM IN TUNGSTEN BY NONDESTRUCTIVE ACTIVATION ANALYSIS. Quittner, P.; Simonits, A.; Elek, A. (Central Research Inst. for Physics, Budapest). Talanta, 14: 417-20(Mar. 1967).

The sodium and aluminum content of tungsten was measured by thermal neutron activation analysis. The concentration of aluminum was evaluated from the 1.78 MeV and that of sodium from the 2.76 MeV full energy peaks. The minimum detectable concentrations of these impurities were 0.04 μg of aluminum and 0.07 μg of sodium per 100 mg of tungsten. (auth)

15850 PRECIPITATION FROM HOMOGENEOUS SOLUTION BY PHOTOCHEMICAL ACTION. DETERMINATION OF THORIUM. Das, M.; Heyn, Arno H. A.; Hoffman, Morton Z. (Boston Univ.). Talanta, 14: 439-41(Mar. 1967).

Thorium was precipitated from homogeneous solution by photochemical reduction of periodate to iodate in a solution containing thorium and perchloric acid by means of a 2537 Å low-pressure mercury vapour lamp. For weighing, the precipitate was redissolved, precipitated once as thorium hydroxide, and finally as thorium oxalate, which was ignited to thorium dioxide. Quantitative results were obtained in the range 35 to 180 mg of thorium. The advantages of photochemical methods lie in the temperature-independent control of the experimental parameters (light intensity, time of exposure, and nature of the radiation). (auth)

15851 CONTRIBUTIONS TO THE BASIC PROBLEMS OF COMPLEXOMETRY. XXIII. DETERMINATION OF THORIUM, SCANDIUM, AND SOME LANTHANIDES IN THE PRESENCE OF EACH OTHER. Pribil, Rudolf; Horacek, Jan (Heyrovsky Polarographic Inst., Prague). Talanta, 14: 313-16(Mar. 1967).

A method is described for the determination of thorium, scandium, and the sum of light lanthanides, in the presence of each other. The method is based on the titration of thorium plus scandium with DCTA (1,2-diaminocyclohexanetetraacetic acid) at pH 2.5 to 3.5, with Xylenol Orange as indicator. After addition of TTHA (triethylenetetraminehexa-acetic acid) the thorium-DCTA complex was converted into the thorium-TTHA complex, according to the equation Th-DCTA + TTHA = Th-TTHA + DCTA. Simultaneously, free lanthanum, cerium, praseodymium, and neodymium reacted with TTHA. The excess TTHA and the liberated DCTA were determined by titrations with zinc and with lanthanum solutions according to the equations DCTA + TTHA + 3Zn = Zn-DCTA + Zn_2-TTHA and DCTA + TTHA + 2La = La-DCTA + La-TTHA. From the results, the amounts of thorium and scandium, and the sum of the lanthanide concentrations, were easily calculated. Further possibilities, e.g., determination of heavier lanthanides, are briefly discussed. (auth)

15852 NEUTRON ABSORPTIOMETRIC TITRATION. Toelgyessy, J.; Varga, S.; Dillinger, P. (Slovak Technical Univ., Bratislava). Talanta, 14: 441-2(Mar. 1967).

A method is outlined for detection of two-phase titration endpoints by means of an abrupt change in the neutron-absorption characteristics of one of the phases. One of the components of the precipitate must have a large neutron absorption cross-section, and the disappearance or appearance of neutron absorption by the supernatant liquid from the precipitation reaction then marks completion of precipitation. (auth)

15853 DETERMINATION OF BORON BY THERMAL NEUTRON CAPTURE GAMMA-RAY ANALYSIS. Garbrah, B. W.; Whitley, J. E. (Scottish Research Reactor Center, Glasgow). Anal. Chem., 39: 345-9(Mar. 1967).

Thermal neutron capture γ-ray analysis was applied to the determination of boron in steel using a 2- by 2-inch NaI(Tl) crystal. Analysis is based on the well known 477-keV γ ray which is emitted in 93% of all thermal neutron captures in boron. Correction factors provided for thermal neutron flux depression in boron also make the technique applicable to the determination of large boron samples. (auth)

15854 X-RAY SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN SILICA–ALUMINA CATALYSTS. Stone, Irving C. Jr.; Rayburn, Kenneth A. (W. R. Grace and Co., Clarksville, Md.). Anal. Chem., 39: 356-7(Mar. 1967).

An x-ray spectrographic method, requiring less than 2 hours to perform, was developed for the determination of the most abundant rare earths, cerium, lanthanum, neodymium, praseodymium, and samarium, in silica–alumina catalysts. The data yield individual rare earth contents which may be summed for a total rare earth value. (J.G.B.)

15855 AMMONIUM HEXACYANOCOBALT FERRATE AS AN IMPROVED INORGANIC EXCHANGE MATERIAL FOR DETERMINATION OF ^{137}Cs. Petrow, Henry G. (New York Univ., Tuxedo); Levine, Harry. Anal. Chem., 39: 360-2(Mar. 1967).

Ammonium hexacyanocobalt ferrate was prepared and used as a substitute for potassium hexacyanocobalt ferrate in a previously reported procedure for the ion exchange determination of cesium-137. The accuracy, precision, and sensitivity of the method were improved by replacing the potassium ions with ammonium ions, thereby removing the interference in the cesium-137 region of the spectrum caused by the decay of potassium-40 in natural potassium. (J.G.B.)

15856 SIMPLIFIED METHOD FOR DETERMINATION OF RADIOACTIVE ^{45}Ca IN BIOLOGICAL MATERIAL BY GEL SCINTILLATION COUNTING. Turpin, R. A.; Bethune, J. E. (Univ. of Southern California, Los Angeles). Anal. Chem., 39: 362-4 (Mar. 1967).

Calcium-45 was determined in biological material by a procedure in which usually insoluble calcium salts are held in a finely

divided suspension in a gel scintillator for counting. Four counting systems containing 1% 2,5-diphenyloxazole(DPO), Cab-O-Sil, ethanol, and toluene were studied in order to determine the effects of nitric acid and ethylene glycol on the counts recovered. The toluene–ethanol mixture gave the highest efficiency. Ethylene glycol and nitric acid produced quenching. Advantages of the method are simplicity, speed, accuracy, and a capacity for calcium salts in any form. (J.G.B.)

15857 SEPARATION OF BORIC ACID FROM URANYL NITRATE BY ANION EXCHANGE CHROMATOGRAPHY. Muzzarelli, R. A. A. (Univ. of Sherbrooke, Can.). Anal. Chem., 39: 365-6(Mar. 1967).

The chromatographic behavior of boric acid on anion exchange resin in ethyl ether was studied in order to establish experimental conditions for a rapid quantitative separation of boric acid from uranyl nitrate with no hazard of losses of boric acid by evaporation. It was found that boric acid was retained by the ion exchange resin; uranyl nitrate was not. Hydrochloric acid was used for the elution of boric acid. The method is rapid and permits the determination of low levels of boron in uranium. (J.G.B.)

15858 RADIOCHEMICAL DETERMINATION OF PLUTONIUM IN SOIL AND OTHER ENVIRONMENTAL SAMPLES. de Bortoli, M. C. (EURATOM, Ispra, Italy). Anal. Chem., 39: 375-7(Mar. 1967).

Several previously reported procedures were tested and a rapid and quantitative electrodeposition method was used for the determination of plutonium in air filters and soil samples. The separation of plutonium from air filters was accomplished by an anionic exchange procedure based on the absorption of iron and plutonium from 9M HCl and on the selective elution of plutonium with an HCl–HF mixture. A new ion exchange procedure, based on differing stabilities of the complexes formed by plutonium and iron with EDTA, was developed to separate plutonium from the bulk of iron in soil samples. The average chemical recovery in soil samples was 67.9% with a standard deviation of the mean of 32.2%. Air filter samples yielded for the chemical recovery a value of 79.9% with a standard deviation of 15.5%. (J.G.B.)

15859 PRODUCTION OF ^{234}Th TRACER. Bhatki, K. S. (Tata Inst. of Fundamental Research, Bombay). Anal. Chem., 39: 401-3(Mar. 1967).

A cation exchange resin was used for the separation of Th^{4+} as ^{234}Th, (UX_1), from uranyl nitrate. Because of its highly charged nature, UX_1 was mainly adsorbed near the top of the column and the uranium selectively eluted. Distribution coefficients are tabulated. (J.G.B.)

15860 MICROANALYTICAL DETERMINATION OF NEODYMIUM. Aliotta, Guillermo; Cabezali, Clyde B. (Univ. Nacional del Sur, Bahia Blanca, Argentina). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 111-14(Jan. 1967). (In Spanish).

Two methods for the microanalytical determination of Nd are presented. The first one is a gravimetric method. It is based on precipitation of Nd as rhodizonate and its calcination to oxide. This technique was studied on micro and macro scales, and the results were compared with the classical oxalate method. The second method is a colorimetric one; Nd is precipitated as rhodizonate and dissolved with EDTA in a NH_4Cl–NH_3OH buffered medium at pH 9.4. Different results on optical density for various concentrations have been presented. A calibration curve was drawn to verify the validity of Lambert and Beer's law. (auth)

15861 AUTOMATIC AND COMPUTER-COUPLED NUCLEAR ACTIVATION ANALYSIS. Wainerdi, R. E.; Fite, L. E. (Texas A and M Univ., College Station). Acta Chim. Acad. Sci. Hung., 50: 33-8(1966).

A survey of the automatized measuring-system for activation analysis is given. Results achieved at the Texas University are discussed. (auth)

15862 NUCLEAR METHODS IN CHEMICAL ANALYSIS. Broda, E.; Schoenfeld, T. (Univ. of Vienna). Acta Chim. Acad. Sci. Hung., 50: 49-62(1966).

A survey of nuclear methods in chemical analysis, covering applications of radioactive tracers, activation analysis as well as analysis with radionuclides as radiation sources, is given. Particular attention is given to classification for the various methods: (auth)

15863 DETERMINATION OF ARSENIC IN ANTIMONY–IRON MATRICES BY ACTIVATION ANALYSIS. Dams, R.; Hoste, J. (Ghent Univ.). Acta Chim. Acad. Sci. Hung., 50: 111-18(1966).

A procedure for the quantitative determination is of arsenic in 60% antimony and 14% iron was developed. The antimony and iron matrix was separated by solvent extraction with isopropyl ether and the arsenic was separated from zinc by precipitation with thioacetamide. The decontamination factors were higher than 5×10^3. The ^{76}As was measured in the presence of non-negligible ^{122}Sb activity. It was determined gamma spectrometrically (measurement at two different energy levels) and by integral gamma counting (two measurements at different times). With the addition method of analysis a straight line was obtained. The activation analyses were carried out in two ways. The arsenic activity induced in the sample was compared with the activity induced in an identical sample to which a known amount of arsenic was added. A second determination was performed by the usual procedure, namely comparison against a standard of spectrographically pure antimony and iron oxides with known arsenic concentrations. Concentrations ranging from 900 to 15 ppM were determined by a neutron irradiation of 2 hours at 5×10^{11} n/cm^2/sec. The chemical procedure takes less than 2 hours. (auth)

15864 DETERMINATION OF NEODYMIUM BY ACTIVATION ANALYSIS FOR CONTROL OF THE PREPARATION OF ^{147}Pm. Travesi, A. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 67-77(Jan. 1967). (In Spanish).

A simple, inexpensive, nondestructive neutron activation analysis method is described for the determination of up to 0.02 mg/ml neodymium. The method is appropriate for process control in the preparation of ^{147}Pm. ^{151}Nd is produced by neutron irradiation, and its activity is selectively measured by gamma spectrometry with the decay of the ^{151}Nd photoelectric peaks being followed with a multichannel analyzer. The optimum irradiation time to obtain the most favorable ^{151}Nd/^{149}Nd activity relation was studied, and the most appropriate photoelectric peak to best maintain this relation was selected experimentally. Chlorine present in the samples was eliminated prior to the irradiation to eliminate its interference. The method for elimination of the chlorine interference was checked with ^{147}Nd as a tracer to determine that no losses of Nd occur in the elimination process. (B.L.M.)

15865 DETERMINATION OF URANIUM IN ITS CONCENTRATES. Petrement, J.; Palomares, F. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 57-66(Jan. 1967). (In Spanish).

A method is described for determination of U in its concentrates of the order of 70 to 85% as U_3O_8. Depending on the concentration of U, the optimum conditions for its separation were established. The U was extracted with TBP with methyl isobutyl ketone or CCl_4 as diluents and with aluminum nitrate as salting agent. Re-extraction of the U from the organic phase was carried out in 2N H_2SO_4 in the presence of Cd metal to reduce the U(VI) to U(IV) to favor the shift of the equilibrium in the aqueous phase. The U was determined with $KMnO_4$ using barium diphenylaminosulfonate as an indicator. The effectiveness of the method for the separation of U from impurities was evaluated, and the results obtained by the method were subjected to statistical analysis and compared with results obtained by other methods. (B.L.M.)

15866 RAPID DETERMINATION OF THE RARE EARTHS IN PHOSPHATE ROCK. Kinnunen, J.; Wennerstrand, B. (Outokumpu Oy, Pori, Finland). Chem. Anal., 56: 24-5(Jan. 1967).

A rapid method was developed for determination of rare earths in phosphate rocks using ethylenedinitrilotetraacetate (EDTA). Various methods and masking techniques are offered for interferences from silica, sulfate, aluminum, phosphate, lead, calcium, barium, magnesium, and strontium. The separations may also be used for concentrating rare earths in samples to be analyzed by atomic absorption flame photometry. (P.C.S.)

15867 DETERMINATION OF RARE EARTHS IN PHOSPHATE ROCK BY ATOMIC ABSORPTION FLAME PHOTOMETRY. Kinnunen, J.; Lindsjoe, O. (Outokumpu Oy, Pori, Finland). Chem. Anal., 56: 25-7(Jan. 1967).

A simple, rapid, accurate, and broadly applicable method for the determination of the individual rare earths was developed using atomic absorption flame photometry. Interference by other rare earths, common anions, and most metals was small with the most serious interferences caused by fluoride, silicon, and aluminum. For Nd, cerium interfered slightly; silicon, aluminum, and fluoride interfered seriously. For Y, interference included sulfuric, perchloric, nitric, and phosphoric acids, fluoride, cerium, silicon, and aluminum. For Eu, silicon, aluminum, and fluoride interfered seriously. A single-beam instrument gave a better signal than did the double-beam model. Principles are applicable to most of the rare earths in ores, concentrates, and mixed oxides as well as for the control of purification processes in the production of pure rare earth oxides and with appropriate modification to the determination of individual rare earths in diverse materials including metals, alloys, and glasses. (P.C.S.)

15868 TITRATION OF URANIUM(IV) WITH CERIUM(IV) SULFATE USING METHYL ORANGE OR METHYL RED AS IN-

DICATOR. Rao, K. Bhaskara (Madras Aluminium Co., Ltd.). Chem. Anal., 56: 28-9(Jan. 1967).

Studies on determination of U(IV) with Ce(IV) sulfate showed that this titration can be conducted at room temperature in the absence of phosphoric acid by employing either methyl orange or methyl red as indicator in acidic media. In 1.5M perchloric acid or 1M HCl, the end-point color change with either indicator was rapid and sharp. In H_2SO_4 the color change occurred in 15 to 20 sec. Titration was not possible in 1M HNO_3 because of premature end point. Color changes in all cases were irreversible. (P.C.S.)

15869 DETERMINATION OF RARE EARTHS IN THE PRESENCE OF PHOSPHATE. PART XXVI. CHELOMETRIC METHODS IN RAPID APPLIED ANALYSIS. Pribil, R.; Vesely, V. (Heyrovsky Polarographic Inst., Prague). Chem. Anal., 56: 23-4(Jan. 1967).

A procedure for the determination of rare earths and scandium in phosphates was developed using [(carboxymethyl)imino] bis-[(ethylenenitrilo)] tetraacetate (DTPA) and NaH_2PO_4. Addition of ascorbic acid or hydroxylamine hydrochloride prevented precipitation of even traces of phosphates. Using back-titration in an excess of DTPA, individual rare earths were determined. Thorium precipitated as a phosphate in DTPA and had to be removed before determination. Typical results for La, Ce, Nd, Sm, Gd, Tb, Ho, Er, and Yb are given. (P.C.S.)

15870 IMPROVED SOLUBILIZATION PROCEDURES FOR LIQUID SCINTILLATION COUNTING OF BIOLOGICAL MATERIALS. Hansen, D. L.; Bush, E. T. (Nuclear-Chicago Corp., Des Plaines, Ill.). Anal. Biochem., 18: 320-32(Feb. 1967).

Hyamine hydroxide and NCS (a quaternary ammonium base) were found to be capable of solubilizing soft tissues and many purified biological materials so that low-energy beta emitters (^3H and ^{14}C) can be counted with true solution efficiencies, as determined by internal standardization, channels ratio, etc. Alcoholic KOH did not. Highest figures of merit were obtained with NCS, and in a number of cases these compare favorably with those attainable by combustion techniques. Improved digestion, bleaching, and dilution procedures are described. (auth)

15871 EXTERNAL STANDARDIZATION IN LIQUID SCINTILLATION COUNTING OF HOMOGENEOUS SAMPLES LABELED WITH ONE, TWO, OR THREE ISOTOPES. De Wachter, R.; Fiers, W. (State Univ. of Ghent). Anal. Biochem., 18: 351-74 (Feb. 1967).

By properly selecting gain and discriminator settings for counting the external standard γ source it was possible to obtain an exponential relationship between external standard count rate and quencher concentration. This allows the construction of linear calibration curves for counting efficiency of β-emitters versus external standard count rate for single-labeled, as well as double- or triple-labeled, samples by using double logarithmic and semilogarithmic graphs. The degree of quenching of the sample was determined by a short preliminary count of the external standard source, using constant gain and discriminator settings regardless of the isotope under study. This allows the selection of optimal gain and discriminator settings for counting a sample containing up to three isotopes of different energy (e.g., ^3H, ^{14}C, and ^{32}P) and an unknown quencher. Derivation of these instrument settings and of the resulting absolute efficiencies for the three isotopes in three different channels from the observed external standard count rate is described in detail. (auth)

15872 INCREASED EFFICIENCY IN LIQUID SCINTILLATION COUNTING: GLASS FIBER DISCS AND A NEW SCINTILLATOR. Malt, Ronald A.; Miller, Walter L. (Massachusetts General Hospital, Boston. Harvard Univ., Boston). Anal. Biochem., 18: 388-91(Feb. 1967).

The efficiency of various scintillators used with glass fiber or membrane filters was compared by counting tritium-labeled mouse kidney ribosomal RNA. Scintillators used were Liquifluor (toluene-base), Aquafluor (dioxane-base), and Bray's solution. Results indicated that radioactivity could be counted just as accurately and more economically by using Liquifluor or Aquafluor scintillator and glass-fiber discs than by using NH_4OH digests on Millipore filters in Bray's medium. (J.G.B.)

15873 QUANTITATIVE DETERMINATION OF RARE EARTHS (La–Lu) AND YTTRIUM IN SILICATE ROCKS. Herrmann, Albert Guenter; Wedepohl, Karl Hans (Univ., Goettingen, Ger.). Z. Anal. Chem., 225: 1-13(1967). (In German).

A chemical procedure for concentrating the rare earth elements from silicate rocks ($\Sigma RE \approx 10 - 1000$ ppM) is described. After precipitation of the rare earth oxalates the individual elements are quantitatively determined by x-ray fluorescence (La, Ce, Pr, Nd, Sm, Gd, Dy, Er, Yb) and by optical emission spectrography (Eu, Tb, Ho, Tm, Lu). A technique similar to isotope dilution has been applied utilizing the fact that no difference in chemical behavior among the rare earths is to be expected. Y is determined by x-ray fluorescence without chemical pretreatment. The accuracy of the methods reported is comparable to those of neutron activation and γ-spectrometry. (auth)

15874 NEITRONOAKTIVATSIONNYI ANALIZ. (Neutron Activation Analysis). Breslav, V. I. (ed.). Riga, Izdatel'stvo Zinatne, 1966. 148p.

Fourteen articles are included on the problems and methods of activation analysis in physics, chemistry, and biology. The first four articles include data on scintillation gamma spectra for rare earth radioisotopes, analysis of spectral problems of activation analysis related to the sensitivity criterion of the method, effects of neutron flux reduction in the specimen, and the feasibility of oxygen determination by means of reactor neutrons. The remaining articles discuss concrete methods of neutron activation analysis, including gamma spectra of short-lived isotopes produced in a reactor and an activation method for measuring large doses and fluxes of gamma emission. Neutron activation methods for the rapid determination of micro-impurities of Dy and Sm in Y_2O_3, determination of Al, Na, Mn, Sb, Cu, and As in LiF, and determination of Cu, Mn, and Zn in human hair and in blood serums are described. (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 15830, 15946, and 15947.

15875 (DP-MS-66-67) MOESSBAUER EFFECT WITH ^{241}Am SOURCES. Stone, J. A.; Pillinger, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 2, 1966. Contract AT(07-2)-1. 11p. (CONF-661208-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Nashville, Tenn.

Unusual characteristics observed in the Moessbauer spectra of several Am compounds are presented. Velocity spectra of a $^{241}AmO_2$ source were obtained at 77°K and at 4.2°K. At both temperatures major resonances were observed at 0 and 2.5 cm/sec. Also, a strong resonance at −4.1 cm/sec was present in the 4.2°K spectrum. The velocity spectrum of a metallic ^{241}Am source, of indeterminate composition, showed a very broad resonance centered at −1.1 cm/sec at 4.2°K. With $^{241}AmF_3$ a strong resonance at −4.4 cm/sec was observed at both 77 and 4.2°K. The association of the different lines observed with oxidation states is discussed. (P.C.H.)

15876 (DP-MS-66-68) MOESSBAUER EFFECT IN ^{231}Pa. Croft, W. L.; Stone, J. A.; Pillinger, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 10, 1966. Contract AT(07-2)-1. 8p. (CONF-661208-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Nashville, Tenn.

Nuclear properties that made ^{231}Pa a promising candidate to exhibit the Moessbauer effect are described. Moessbauer velocity spectra clearly demonstrate a Moessbauer effect in ^{231}Pa at 4.2°K, even though the apparent effect is very small (on the order of 0.1%). The spectra show a broad absorption centered at 0 cm/sec with some indication of its being a doublet. (P.C.H.)

15877 (JINR-E6-3076) EXPERIMENTS ON CHEMICAL PROPERTIES OF ELEMENT 102. I. ADSORPTION OF A CHLORIDE OF ELEMENT 102 FROM THE GASEOUS PHASE. Chuburkov, Yu. T.; Tsaletka, R.; Shalaevskii, M. R.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 14p. Dep. mn.

Studies were made of the chemical properties of element 102. The volatility of the chloride of this element was similar to the volatilities of chlorides of Th, Cf, and Fm. There was a high degree of separation of element 104 from spontaneously fissioning $^{256}102$ in the experiments on chemical identification of $^{260}104$ due to a sharp difference in the volatility of their chlorides. (M.C.G.)

15878 (MIT-905-81) CHEMISTRY PROGRESS REPORT. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Dec. 31, 1966. Contract AT(30-1)-905. 103p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies in: nuclear chemistry; instrumental chemistry; uses of organic isotopes; and physical chemistry. (P.C.H.)

15879 (NRL-6466) STATUS OF RESEARCH ON LUBRICANTS, FRICTION, AND WEAR. Bowers, R. C.; Murphy,

C. M. (Naval Research Lab., Washington, D. C.). July 25, 1966. 151p. CFSTI $3.00 cy, $0.65 mn.

Progress made during the last decade in advancing the knowledge of the science and application of lubricants is reviewed and summarized. Advances were made during this period in understanding the fundamental mechanisms operable in friction, wear, and lubrication. The adhesion theory of metallic friction was extended to include high polymers, hard oxides, and brittle materials. The mode of deformation, real area of contact, and the role of junction growth between sliding solids received more attention. Systematic studies of adhesive and abrasive wear increased the understanding of the wear process. Considerable progress was made in the development of solid-film lubricants. New synthetic liquid lubricants, having unusual physical properties, were prepared, studied, and evaluated for special applications. Emphasis was placed on synthesizing lubricants, which are stable at increasingly high temperatures. Progress was made in developing new nonsoap thickeners for the preparation of greases from both petroleum and synthetic oils. New environmental conditions and more extreme operating requirements created many lubrication problems. Lubricants may be subjected to high vacuum, radiation, and cryogenic or burning rocket fuel temperatures. Attention is called to areas in research and development where solutions are needed. (auth)

15880 (ORO-3518-2) VOLTAMMETRIC AND EMF MEASUREMENTS ON THE NICKEL-NICKEL(II) COUPLE IN MOLTEN FLUORIDES. Manning, D. L.; Mamantov, Gleb; Jenkins, H. W. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville. Dept. of Chemistry). Jan. 5, 1967. Contract AT(40-1)-3518. 5p. (CONF-670401-8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

An investigation was made on the use of controlled-potential voltammetry and emf measurements on the study of the Ni/Ni^{2+} couple in molten LiF-NaF-KF (46.5 to 11.5 to 42 mole %) and LiF-BeF_2-ZrF_4 (65.6 to 29.4 to 5.0 mole %). The analytical utility of the voltammetric approach to the determination of Ni in the molten state was demonstrated from the linear dependence of peak current (i_p) on Ni concentration over the range of approximately 10 to 80 ppM. The emf studies showed that from the standpoint of Nernstian reversibility, the nickel couple appears to be a good choice for a reference electrode in molten fluorides. (P.C.H.)

15881 (SCL-DR-67-11) LITERATURE SURVEY OF CARBORANE CONTAINING POLYMERS. Weaver, R. W. (Sandia Corp., Livermore, Calif.). Feb. 1967. Contract AT(29-1)-789. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A survey of the literature of carborane-containing polymers was made. The work of five companies in this field is reviewed. A bibliography of 138 articles and 49 patents is included. (auth)

15882 (UCRL-17019) THE MOLECULAR-BEAM ELECTRIC-RESONANCE SPECTRA OF LiF, NaF, AND KCl. Hollowell, Craig D. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 7, 1966. Contract W-7405-eng-48. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Radiofrequency spectra were observed in the low vibrational and rotational states of $^6Li^{19}F$, $^7Li^{19}F$, $^{23}Na^{19}F$, $^{39}K^{35}Cl$, and $^{39}K^{37}Cl$ by the molecular-beam electric resonance method. Microwave $J = 1 \rightarrow 0$ transitions were also observed for $^{23}Na^{19}F$. Analysis of the spectra made possible the determination of accurate dipole moments, rotational constants, and nuclear hyperfine interaction constants. A polarizable ion model of the alkali halide molecules is presented. This model includes several effects, previously neglected, and successfully agrees with experimental data. (auth)

15883 (UCRL-17169) KINETICS OF FORMATION OF XENON FLUORIDES. Weaver, Clayton Fred (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 114p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The temperature dependence of the near ultraviolet region of the absorption spectra of F_2 and XeF_2 was determined to 400°C in fluorinated nickel cells with calcium fluoride windows. That of XeF_4 was determined to 250°C. This spectral information was used to study the kinetics of the formation of XeF_2 and XeF_4 in the same temperature regions and in the same nickel cells. Experimental conditions were chosen to cause the reactions to terminate at XeF_2 or XeF_4. With a total pressure of reactants in the 10 to 40 mm range and Xe to F_2 ratios of 10 or more the reaction $Xe + F_2 \rightarrow XeF_2$ occurred. Under these conditions the reaction was zero order in Xe and first order in F_2 over the temperature range 190 to 400°C. With total reactant pressures of 10 to 20 mm and F_2 to Xe ratios of 16 or more the reaction $Xe + 2F_2 \rightarrow XeF_4$ occurred with XeF_2 as an intermediate. Under these conditions in the temperature range 190 to 250°C the formation of XeF_2 was zero order in F_2 and first order in Xe, just the opposite of the results above. The formation of XeF_4 was zero order in F_2 and first order in XeF_2. The reactions were heterogeneous, even though they were very reproducible. The activation energies were uniformly low ranging from 12.8 to 15.7 kcal/mole. A mechanism involving adsorption and dissociation of F_2 on the NiF_2 surface is proposed. (M.C.G.)

15884 ON THE QUESTION OF THE EXISTENCE OF $(UDipy_3)(SCN)_6$. Herzog, S.; Waicenbauer, W. (Ernst-Moritz-Arndt-Univ., Griefswald, Ger.). Z. Chem., 6: 383(Oct. 1966). (In German).

The $(UDipy_3)(SCN)_6$ reported by Allison and Mann (J. Chem. Soc., 2915 (1949)) was prepared according to their instructions. It was previously observed (P. Gans and B. C. Smith, J. Chem. Soc., 4177 (1964)) that in the presence of bases, such as 2,2′-dipyridyl, o-phenanthroline, and tertiary phosphines, hexachlorouranates(IV) or alkoxouranium(IV) compounds are formed which are oxidized to tetrachlorodioxouranates(VI). On this basis, the compound prepared by Allison and Lang might have been a uranyl compound; in fact, attempts to prepare the compound in the absence of air failed. The formula suggested for the compound is $(DipyH)_3UO_2(SCN)_5$, which also fits Allison's and Mann's analysis. The compound is thus identical with one prepared by Markov and Traggeim (Zh. Neorg. Khim., 5, 1467 (1960)), although the mp reported by the latter authors could not be duplicated. (BBB)

15885 HYDROGEN SHIFTS. IV. KINETIC ISOTOPE EFFECT OF THE 1,5-HYDROGEN SHIFT IN cis-PENTADIENE-1,3. Roth, Wolfgang R.; Koenig, Joachim (Univ., Cologne). Ann. Chem., 699: 24-32(1966). (In German).

The preparation of cis-1,1-dideuteropentadiene-1,3 was effected through the intermediacy of cis-butene-2-carboxylic acid-1, its methyl ester (via diazomethane), cis-1,1-dideuteropenten-3-ol-1 (via $LiAlD_4$), the corresponding iodide (from the tosylate of the previous alcohol, and the quaternary ammonium hydroxide (from treatment of the iodide with trimethylamine and Ag_2O. Its isomer, cis-5,5,5-trideuteropentadiene-1,3, was prepared from vinylacetylene and trideuteromethyl iodide to give the enyne, which was reduced to the desired product with a Lindlar catalyst. The thermal 1,5-hydrogen migration of the 1,1-dideutero compound was studied kinetically at 185 to 205°C. An intramolecular uncatalyzed first-order reaction with $\Delta H‡ = 35.4$ Kcal/mole and $\Delta S‡ = -7.1$ eu/mole was found. Data for the 1,5 deuterium shift were compared with these results and led to determination of a kinetic isotope effect of $k_H/k_D = 1.15 \exp(1400/RT)$, a value in agreement with the assumption of a symmetrical transition state for the reaction. (BBB)

15886 THE REACTION OF 2,4,6-TRI-t-BUTYLPHENOXY RADICAL WITH UNHINDERED PHENOLS. DaRooge, Margaret A.; Mahoney, Lee R. (Ford Motor Co., Dearborn, Mich.). J. Org. Chem., 32: 1-6(Jan. 12, 1967).

The products and kinetics for the reaction of 2,4,6-tri-t-butylphenoxy radical with 3- and 4-substituted phenols were determined in benzene at 24 ± 0.5°C. The second-order rate constants vary over a range of 10^4, demonstrating the high selectivity of this radical. The value of k_H/k_D for the reaction of the hindered phenoxy radical with 4-phenylphenol-OH and -OD was found to be ≥7.5. A critical examination of the σ and σ^+ correlations is presented for this and other free-radical reactions. (auth)

15887 PHOTOCHEMICAL OXIDATION OF ALIPHATIC ALDEHYDES BY URANYL IONS. Venkatarao, K.; Santappa, M. (Univ. of Madras). Z. Phys. Chem. (Frankfurt), 54: 101-9(Mar. 1967).

The photochemical oxidation of formaldehyde and acetaldehyde by uranyl perchlorate in aqueous perchloric acid was studied at three monochromatic wavelengths, 365, 405, and 436 mμ. The rate of uranous ion formation was directly proportional to light-intensity and light-absorption fraction by the active species. Plots of reciprocal rates vs reciprocal aldehyde concentrations were linear with intercepts on the ordinates indicating complex formation between uranyl ions and the aldehydes. Hydrogen ions had marked effect on the rates. The results were consistent with the hypothesis that there is complex formation between uranyl ion and aldehyde, and the excitation of the complex (active species) is the primary photochemical process. The excited complex decomposes by an electron-transfer process yielding U^{4+} and substrate radical in a secondary dark reaction. Quantum yields for U^{4+} production increased with decreasing wavelength of light. (auth)

15888 A KINETIC STUDY OF THE REACTION BETWEEN NEPTUNIUM(IV) AND CHROMIUM(II). Thompson, Richard C.;

Sullivan, James C. (Argonne National Lab., Ill.). J. Amer. Chem. Soc., 89: 1096-8(Mar. 1, 1967).

The empirical form of the rate law for the reaction Np(IV) + Cr(II) → Np(III) + Cr(III), in perchloric acid–lithium perchlorate media, is $-d[Np(IV)]/dt = k'[Np(IV)][Cr(II)][H^+]^{-1.27\pm0.02}$ at 25°C. The variation of k' with temperature is presented. (auth)

15889 THE REACTION BETWEEN EXCESS NEPTUNIUM(V) AND CHROMIUM(II) IN PERCHLORATE SOLUTION. Thompson, Richard C.; Sullivan, James C. (Argonne National Lab., Ill.). J. Amer. Chem. Soc., 89: 1098-1102(Mar. 1, 1967).

The kinetics of the reaction Np(V) + Cr(II) = Np(IV) + Cr(III) was studied in acid perchlorate solutions from 0.02 to 0.20 M $HClO_4$. The reaction was complicated by a competitive consecutive reaction between the Cr(II) reactant and the Np(IV) product. The rate law for the 1-equiv reduction of Np(V) by Cr(II) is $-d[Np(V)]/dt = k_1[Np(V)][Cr(II)][H^+]^{0.78}$, where $k_1[H^+]^{0.78}$ is interpreted to equal $k_0[H^+]e^{\delta[H^+]}$. Values of ΔH^* and ΔS^* appropriate to the k_0 term were found to be 1.85 kcal/mole and −38.4 eu. ^{18}O tracer results indicated the formation of an inner-sphere activated complex. (auth)

15890 NITROSATIVE CLEAVAGE OF TERTIARY AMINES. Smith, Peter A. S.; Loeppky, Richard N. (Univ. of Michigan, Ann Arbor). J. Amer. Chem. Soc., 89: 1147-57(Mar. 1, 1967).

Tertiary amines reacted with aqueous nitrous acid and underwent dealkylation to form a carbonyl compound, a secondary nitrosamine, and nitrous oxide. The ratios of products from meta- or para-monosubstituted tribenzylamines were little affected by the electronic influence of the substituents and obeyed the Hammett equation with a small negative value of the reaction constant. Susceptibility of an amine to nitrosative cleavage was markedly reduced by base-weakening effects, and was prevented altogether by quaternization. Quinuclidine, in which the tertiary nitrogen is at a bridgehead, was inert. α substituents in tribenzylamines and benzyldiethylamines strongly shifted dealkylation to the unsubstituted groups, regardless of the electronic character of the α substituent (e.g., alkyl or carboethoxy). Tribenzylamine-α,α-d_2 showed a deuterium isotope effect $k_H/k_D = 3.78$. The facts were correlated by a mechanism involving formation of an N-nitrosoammonium ion and cis elimination of nitroxyl to form a ternary ammonium ion, $R_3N^+{=}CR_2$, which then underwent hydrolysis and further nitrosation. (auth)

15891 OXIDATIONS OF AMINES. III. DUALITY OF MECHANISM IN THE REACTION OF AMINES WITH CHLORINE DIOXIDE. Hull, L. A.; Davis, G. T.; Rosenblatt, D. H.; Williams, H. K. R.; Weglein, R. C. (Army Edgewood Arsenal, Md.). J. Amer. Chem. Soc., 89: 1163-70(Mar. 1, 1967).

Chlorine dioxide reacted with aliphatic amines to give the products of oxidative dealkylation and the reaction was retarded by addition of chlorite ion. Analyses of these data substantiated a single mechanism in which formation of an aminium cation radical was rate controlling. Reactions of chlorine dioxide with dibenzylamine, benzyl-t-butylamine, and benzylamine were retarded by addition of chlorite, but analyses of the data isolate an additional reaction component unaffected by addition of chlorite ion. A similar, but extremely minor, reaction component was isolated in the reaction with trimethylamine-d_9. Deuterium isotope effects were studied with trimethylamine-d_9, α,α-d_2-benzyl-t-butylamine, and α,α-d_2-benzylamine. The isotope effects substantiate the belief that the retarded reaction was that involving formation of the aminium radical by electron abstraction, whereas the unretarded component represents α-hydrogen atom abstraction. (auth)

15892 CATALYSIS OF α-HYDROGEN EXCHANGE. III. EXCHANGE OF ISOBUTYRALDEHYDE-2-d IN THE PRESENCE OF METHYLAMMONIUM IONS. Hine, Jack; Kokesh, Fritz C.; Hampton, K. Gerald; Mulders, Julien (Ohio State Univ., Columbus. Georgia Inst. of Tech., Atlanta). J. Amer. Chem. Soc., 89: 1205-11(Mar. 1, 1967).

The kinetics of dedeuteration of isobutyraldehyde-2-d in the presence of methylammonium chloride was investigated using 2,6-lutidine–2,6-lutidinium chloride buffers and sodium acetate–acetic acid buffers. The results obtained were consistent with the view that much of the dedeuteration was due to the rate-controlling attack of the various bases present on the iminium ion, $Me_2CDCH{=}NHMe^+$. The acidity constant of the 2,6-lutidinium ion was found to be decreased to the same extent by adding methylammonium chloride or sodium chloride but increased by adding 2,6-lutidine or 2,6-lutidinium chloride. Specific medium effects of this type were blamed for differences between the values for certain kinetic constants determined in aqueous solutions with different buffers present. (auth)

15893 CARBONYL OXYGEN EXCHANGE IN GENERAL BASE-CATALYZED ESTER HYDROLYSIS. Bender, Myron L.; Heck, Henry d'A. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 89: 1211-20(Mar. 1, 1967).

The general base catalyzed hydrolyses of ethyl trifluorothiolacetate-^{18}O in 40 vol % tetrahydrofuran and of ethyl trifluoroacetate-carbonyl-^{18}O in 25 vol % acetonitrile were accompanied by carbonyl oxygen exchange with the solvent. The extent of oxygen exchange in the thiol ester experiments was quantitatively predicted from previously determined hydrolysis kinetics and was consistent with an unsymmetrical partitioning of an addition intermediate. With the oxygen ester, partitioning of the intermediate was symmetrical since the partitioning was pH independent. The amount of oxygen exchange observed with the latter compound decreased significantly in the presence of deuterium oxide solvent. Temperature studies with both esters indicated that the activation energies were identical for breakdown of the intermediate to reactants or to products. The deacylations (hydrolyses) of cinnamoyl-α-chymotrypsin-cinnamoyl-carbonyl-^{18}O and p-nitrobenzoyl-α-chymotrypsin-p-nitrobenzoyl-carbonyl-^{18}O at neutral pH were not accompanied by carbonyl oxygen exchange with the solvent. However, in the alkaline hydrolysis of O-cinnamoyl-N-acetylserinamide-cinnamoyl-carbonyl-^{18}O, a model for an acyl-α-chymotrypsin intermediate, oxygen exchange took place. (auth)

15894 INFRARED SPECTRA OF ^{15}N-SUBSTITUTED SCHIFF BASES. Dudek, Gerald (Harvard Univ., Cambridge, Mass.). J. Org. Chem., 32: 822-3(Mar. 1967).

The infrared spectra of several ^{15}N-labeled Schiff bases were obtained and the results provide an estimate of the vibrational coupling in these ketamines. Results indicated that the majority of the bands are shifted by several reciprocal centimeters; therefore, extensive coupling is present. (M.C.G.)

15895 VALENCY STATE OF CHROMIUM IN SEA WATER. Fukai, R. (International Atomic Energy Agency, Monaco). Nature, 213: 901(Mar. 4, 1967).

The valency state in which Cr occurs in seawater is considered significant in connection with the problem of radioactive waste disposal. In order to understand the cycle of radioactive Cr in seawater it is necessary to know the valency state in which the Cr is stable. The contradictory findings of previous investigations are summarised. A differential method was devised for determination of the trivalent and hexavalent Cr in seawater. The principle of the method depends on independent measurements on two equivalent aliquots from the same sample of water; the Cr is directly coprecipitated with iron hydroxide in one sample, with similar coprecipitation in the second sample after reduction with sodium sulphite in acid medium. Hexavalent Cr was formed in all samples. The thermodynamically unstable Cr(III) species was detected in many cases. This suggests some process working against thermodynamic equilibria. (UK)

15896 ANODIC POLARIZATION AND POTENTIAL VS TIME DEPENDENCE. Zarubitskii, O. G. (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zh. Prikl. Khim., 39: 1475-81(July 1966). (In Russian).

Anodic polarization and electrode potential vs time dependence (0 to 200 minutes) were studied for several metals in liquid and solid state in molten sodium hydroxide at 340 ± 2°C. For W, Mo, and Cd, the electrode potential was found to reach a constant level rapidly and then remain constant with time. For Pb, Bi, and Cu, the electrode potential was found to reach a constant level slowly. Such metals as Ag, Au, Pt, Fe, Ni, Ta, Nb, and Zr were found to be air-oxygen electrodes. At 340°C in molten NaOH, the following electrochemical order of metals was established: W, Mo, Cd, Pb, Bi, Cu, Ag, Au, Pt, Fe, Ni, Ta, Nb, and Zr. (ATD)

15897 NEW TERNARY OXIDES OF TETRAVALENT RARE EARTHS AND Th. Paletta, Elisabeth; Hoppe, Rudolf (Univ., Giessen, Ger.). Naturwissenschaften, 53: 611-12(1966). (In German).

The following compounds were prepared and some of their crystalline properties were determined: β-K_2TbO_3, K_2PrO_3, K_2ThO_3, Na_2ThO_3, $LiTbO_3$, $SrTbO_3$, and $BaTbO_3$. (J.S.R.)

15898 THE RATE OF OXYGEN EXCHANGE BETWEEN THE PERRHENATE ION AND WATER. Murmann, R. Kent (Univ. of Missouri, Columbia). J. Phys. Chem., 71: 974-8(Mar. 1967).

The rate law for the exchange of oxygen between perrhenate ion and water in the liquid phase is $R = k_0[ReO_4^-][H_2O] + k_1[ReO_4^-][H_2O][H^+]^2 + k_2[ReO_4^-][H_2O][OH^-]$. The order with respect to water in each rate term is assumed. The experimental order with respect to $[H^+]$ was found to be 1.92 × 0.05 in the $[H^+]$ range of 4×10^{-5} to 6×10^{-3} M and with respect to $[OH^-]$, 0.990 ± 0.016 in the $[OH^-]$ range of 6×10^{-5} to 6×10^{-2} M. At μ(LiCl) = 0.10 and 25°C, k_0 = 1.4 ± 0.1 × 10^{-6} l. mole^{-1} sec^{-1}, k_1 = 3.36 ± 0.15 × 10 l.^{3} mole^{-3} sec^{-1}, and k_2 = 1.555 ± 0.023 × 10^{-4} l.^{2} mole^{-2} sec^{-1}. The Arrhenius

activation energy, E^* (kcal/mole), for each term was found to be 15.44 ± 1.4, 4.16 ± 0.15, and 11.15 ± 0.47, respectively. The rates were slightly affected by changes in μ, and replacement of Na^+ for Li^+ or NO_3^- for Cl^- had only a moderate effect. (auth)

15899 KINETIC ISOTOPE EFFECTS IN HYDROGEN EXCHANGE REACTIONS OF FERROCENE WITH ACID AND BASE. Yakushin, F. S.; Setkina, V. N.; Yakovleva, E. A.; Shatenshtein, A. I.; Kursanov, D. N. (Karpov Inst.of Physics and Chemistry, Academy of Sciences, USSR. Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 206-7(Jan. 1967). (In Russian).

The kinetics of hydrogen exchange of deuterium- and tritium-labeled ferrocene in acid and base media were measured. Hydrogen exchange with liquid ammonia in the presence of potassium amide catalyst was about 30 times faster in ferrocene than in benzene. The kinetic isotopic effect in hydrogen exchange in ferrocene with acid ($k_D/k_T = 1.2$) was considerably lower than in hydrogen exchange with aromatic compounds ($k_D/k_T \approx 2$). The kinetic isotopic effect in hydrogen exchange in ferrocene with liquid ammonia, catalyzed by potassium amide, had an identical value with benzene and naphthalene and confirmed the postulation that the exchange mechanism in the basic media established for other organic compounds also holds for ferrocene. (R.V.J.)

15900 HIGH-TEMPERATURE STUDIES OF PRASEODYMIUM OXIDES BASED ON MEASUREMENTS OF ELECTRIC CONDUCTIVITY AS A FUNCTION OF THE PARTIAL PRESSURE OF EQUILIBRIUM O_2. Wilbert, Yves; Duquesnoy, Alain; Marion, Fernand (College Scientifique Univ., Amiens, France). Compt. Rend., Ser. C, 263: 1539-42(Dec. 19, 1966). (In French).

Study of isothermal variations of electric resistance of praseodymium oxides at high temperature made it possible to define stability regions of the hexagonal oxide $PrO_{1.5}$ and of the non-stoichiometric cubic oxide $PrO_x(1.600 \leq x \leq 1.714)$. Variation of the resistance R_x of this PrO_x oxide followed the $1/R_x - 1/R_{1.6} = K(x - 1.6)$ law. ($R_{1.6}$ is the resistance of the limiting oxide $PrO_{1.6}$.) (tr-auth)

15901 INFRARED SPECTRA OF THE MIXED DIMERS (CH_3COOH–CH_3COOD) AND (CD_3COOH–CD_3COOD). Haurie, Michel; Novak, Alexandre (Faculte des Sciences, Bordeaux. CNRS, Thiais, France). J. Chim. Phys., 63: 1584-6(Nov.-Dec. 1966). (In French).

The infrared spectra of mixed dimers ($CH_3COOH-CH_3COOD$) and ($CD_3COOH-CD_3COOD$) were studied. In passing from the homogeneous dimer to the mixed dimer, the substitution of one of the two acid hydrogens by a deuterium modifies only the vibrations νOH(OD) and γOH(OD). Again submaximums which appeared on the maximums of absorption νOH of the mixed dimers were attributed to the new combinations between fundamental vibrations of the groups. (tr-auth)

15902 A KINETIC MODEL FOR MECHANISMS OF BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE BETWEEN A CARBON ACID AND DEUTERATED MEDIUM. Ford, Warren T.; Graham, Edward W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 89: 689-90(Feb. 1, 1967).

A kinetic model for dissecting the mechanistic components in the base-catalyzed hydrogen–deuterium exchange reaction at asymmetric carbon between N, N-9-trimethylfluorene-2-carboxamide(TFC) and deuterated methanol is reported. Racemization isotope effects and values for the scheme's four rate constants are reported for treatment of TFC with potassium methoxide in deuterated methanol. Solutions of the four simultaneous first-order rate equations are given. (J.G.B.)

15903 MECHANISTIC COMPONENTS IN BASE-CATALYZED HYDROGEN–DEUTERIUM EXCHANGE BETWEEN A CARBON ACID AND HYDROXYLIC SOLVENTS. Ford, Warren T.; Graham, Edward W.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 89: 690-2(Feb. 1, 1967).

Previously reported kinetic equations were utilized in the development of a kinetic model of mechanistic components in the base-catalyzed hydrogen–deuterium exchange between N, N,9-trimethylfluorene-2-carboxamide(TFC) and deuterated methanol in two solvent-base systems. The model assumes that the substrate, once exchanged with the isotopically labeled solvent, never regains its original isotope. In the first experiment, TFC in potassium methoxide and deuterated methanol were used; in the second, deuterated TFC in potassium phenoxide and t-butyl alcohol were used. Rate constants are reported. (J.G.B.)

15904 A COMPARATIVE MEASUREMENT OF REFRACTION INDICES OF LIGHT AND HEAVY WATER AT DIFFERENT TEMPERATURES. APPLICATION TO THE MEASUREMENT OF THE CONCENTRATIONS OF SOLUTIONS OF H_2O–D_2O. Mehu, Annick; Abjean, Rene; Johannin-Gilles, Andree (Faculte des Sciences, Brest, France). J. Chim. Phys., 63: 1569-74(Nov.-Dec. 1966). (In French).

Refractive index of light and heavy water were measured from 15 to 90°C, at different wave lengths by the classical method of minimum deviation. Measurements were made by means of a double cavity hollow prism kept at constant temperature. One cavity was filled with bidistilled water, the other with heavy water. Simultaneous measurements of the refractive indices of H_2O and D_2O were made. (auth)

15905 STUDY OF THE COORDINATION COMPLEXES OF URANYL HALOGENIDES WITH DIMETHYLSULFOXIDE. II. INFRARED ABSORPTION SPECTRA AND ANALYSIS IN NORMAL COORDINATES. Kaufmann, Gerard; Leroy, Maurice J. F. (Faculte des Sciences, Strasbourg). Bull. Soc. Chim. France, No. 12, 3770-4(Dec. 1966). (In French).

The coordination complexes of dimethyl sulfoxide with uranyl chloride and bromide were studied by infrared spectroscopy. An indexing of the bands in the region from 4,000 to 200 cm^{-1} was proposed; a negative variation of the vibration frequency of the S=O group is explained by supposing that the coordination at the U is made by the H atom of dimethyl sulfoxide. An analysis in normal coordinates was developed using the GF method of Wilson that uses a simplified model of symmetry C_s containing 5 masses [$(CH_3)_2SO-U$]; the methyl groups and the acceptor atom were treated as material points having masses of 15.0 and 238, respectively. (tr-auth)

15906 ALKALI FLUORIDE COMPLEXES OF TETRAVALENT PROTACTINIUM. Asprey, L. B.; Kruse, F. H.; Penneman, R. A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Inorg. Chem., 6: 544-8(Mar. 1967). (LA-DC-7144(Rev.)).

Complex fluorides containing tetravalent protactinium and the alkali fluorides (Li, Na, K, Rb) were prepared from MF + PaF_4 starting mixtures and by hydrogen reduction of MF – PaF_5 compounds at 400 to 450°C. LiF · PaF_4 is tetragonal: a = 14.96, c = 6.58 Å. The three rhombohedral compounds, 7MF · 6PaF_4 (M = Na, K, and Rb), are isostructural and have the cell dimensions: a = 9.16 Å, α = 107°54′; a = 9.44 Å, α = 107°09′; and a = 9.64 Å, α = 107°0′, respectively. Monoclinic 4NH_4F · PaF_4 was formed by direct reaction between NH_4F and PaF_4 at temperatures of 25 to 90°; cell dimensions are a = 13.18, b = 6.71, c = 13.22 Å; β = 117° 10′. PaF_4 is monoclinic with cell dimensions: a = 12.86, b = 10.88, c = 8.54 Å; β = 126° 21′. These protactinium(IV) fluoride compounds are isostructural with their uranium analogs. The absorption spectra of Pa(IV) in ND_4F-D_2O solution and in various solid fluorides are presented. For 7RbF · 6PaF_4, 3NaF · PaF_4, and PaF_4, an intense infrared absorption band was observed at ~5485 cm^{-1}, giving a value of ζ_{5f} = 1567 cm^{-1} for Pa(IV). (auth)

15907 STUDY OF THE SYSTEM URANIUM–HYDROGEN AT HIGH PRESSURES. Chevallier, Jacques; Spitz, Jean; Blum, Pierre L. (CEN, Grenoble, France). Compt. Rend., Ser. C, 264: 93-6(Jan. 4, 1967). (In French).

The pressure–temperature–concentration equilibria of the system U–H were studied up to 150 atm and 860°C. At a pressure of 83 atm and a temperature of about 820°C, the hydride UH_{3-x} and the solid solution of hydrogen in gamma uranium became miscible in a solution of uranium and hydrogen with an atomic ratio H/U in the neighborhood of 0.7. (tr-auth)

15908 DETERMINATION OF THE ACID DISSOCIATION CONSTANTS OF PROTONATED CHELATE COMPLEXES FROM THE RATE OF ISOTOPIC EXCHANGE REACTIONS. Szarvas, Pal; Bruecher, Erno (Kossuth Univ., Debrecen, Hungary). Acta Chim. Acad. Sci. Hung., 50: 279-86(1966).

The kinetics of isotopic exchange reactions between Ce^{3+} and $CeEDTA^-$ as well as Lu^{3+} and LuHEDTA ions were investigated. The rate of exchange (R) was determined by the dissociation rate of the HCeEDTA and $HLuHEDTA^+$ protonated complexes into metal and ligand ions. The kinetic equations of the exchange reactions are: $R_{Ce} = 1.06 \times 10^5$ [$CeEDTA^-$][H^+] and $R_{Lu} = 2.82 \times 10^4$ [LuHEDTA][H^+]. A method was worked out to calculate the acid-dissociation constants of protonated complexes from the kinetic data. The pK_H values of the protonated HCeEDTA and $HLuHEDTA^+$ complexes are 3.07 and 3.2, respectively. (auth)

15909 KNOWLEDGE OF THE EXCHANGE CHARACTERISTICS OF DIFFICULTY SOLUBLE HEXACYANOFERRATES(II). Gorenc, B.; Kosta, L. (Fakultaet fuer Naturwissenschaft und Technologie, Ljubljana, Yugoslavia). Z. Anal. Chem., 223: 410-14(1966). (In German).

Distribution coefficients of cesium, rubidium, and potassium between their aqueous solutions and hexacyanoferrates(II) of zinc,

nickel, cobalt, uranyl, iron, cadmium, copper, and silver were determined. Silver hexacyanoferrate(II), characterized by the highest separation factor for the pair rubidium–cesium, was investigated in detail. Its capacity was determined as well as the dependence of the distribution coefficients of rubidium and cesium on the concentration of hydrochloric acid within the range of 1 to 10^{-6} M. The ion exchange properties of silver hexacyanoferrate(II) were also compared with those of ammonium molybdophosphate. (auth)

15910 STUDY OF HYDROGEN ISOTOPE EXCHANGE REACTION OF ALKYL-SUBSTITUTED CYCLOPENTADIENYL-MANGANESE TRICARBONYLS IN ACID MEDIA. Nesmeyanov, A. N.; Kursanov, D. N.; Setkina, V. N.; Kislyakova, N. V.; Kolobova, N. E.; Zlotina, I. B.; Anisimov, K. N. (Inst. of Elementary Organic Compounds, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 30-3(Jan. 1967). (In Russian).

The influence of alkyl groups on the rate of the isotopic exchange reaction of cyclopentadienyl manganese tricarbonyl in acid media was analyzed and the results were correlated to the data for the benzene series. It was found that the influence of the alkyl group is considerably weaker in the cyclopentadiene rings than in benzene. (R.V.J.)

15911 CYCLOHEXANE AND DEUTERIUM ISOTOPIC EXCHANGE OVER COATED METAL CATALYST. Balandin, A. A.; Gudkov, B. S.; Fedorovich, R. M. (Zelinskii Inst. of Organic Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 38-41(Jan. 1967). (In Russian).

Cyclohexane–deuterium exchange over the powder-coated films of Pt, Pd, Ni, Co, Mo, Fe, Au, and Al was studied. It was found that the distribution of deuterium products was not greatly affected by the temperature. A maximum corresponding to $C_6H_6D_6$ was observed on the curve for Pt, Pd, Co, and Ni while for W, Mo, and Fe the distribution was uniform. Simultaneous doublet and sextet exchange processes were observed in the first three metals and only a doublet process in the last three. (R.V.J.)

15912 AN IMPROVED METHOD OF PREPARING AMMONIUM URANYL SULPHATE COMPLEX. (to Reactor Centrum Nederland). British Patent 1,054,540. Jan. 11, 1967. Priority date Aug. 26, 1964, Netherlands.

A process is described for the preparation of substantially spherical grains of an ammonium uranyl sulfate complex suitable for conversion to grains of UO_2 of smaller diameter. A solution of a water-soluble uranyl salt is cooled to a temperature in the range from +3 to −7°C and ammonium sulfate is added to produce a homogeneous precipitate of the complex. The solution is allowed to stand until accretion of the precipitate takes place to produce grains of the complex. An amount of ammonia is added to the solution before the addition of ammonium sulfate sufficient to ensure that the grains formed from the precipitate are substantially spherical but not sufficient to produce an instantaneous lasting precipitate in the solution of the uranyl salt before the addition of the ammonium sulfate. (B.L.M.)

15913 METHOD AND APPARATUS FOR THE CONTINUOUS PRECIPITATION OF PLUTONIUM IN THE FORM OF OXALATE. Auchapt, Pierre; Bouzou, Georges (to Commissariat a l'Energie Atomique). British Patent 1,055,412. Jan. 18, 1967. Priority date Sept. 19, 1963, France.

A method for the continuous precipitation of Pu as the oxalate consists in mixing at room temperature a solution of oxalic acid and a solution of plutonium nitrate, decanting the liquid from the precipitate formed, washing the precipitate with acid, washing with water, and drying. The apparatus for carrying out the continuous precipitation comprises a mixer supplied by means of a conduit for the admission of solutions of oxalic acid and plutonium nitrate. The mixer includes a stirrer and an overflow outlet for the delivery of a suspension of the oxalate precipitate to a settler. A first column is provided for washing the precipitate with acid, and a second column is provided for the water wash. The two washing columns are coupled together by means of transfer devices. The overall shape and size of the apparatus is such as to prevent the occurrence of critical conditions. (B.L.M.)

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Refer also to abstracts 15864, 16299, 16447, and 16561.

15914 (AGN–8180) FISSIOCHEMICAL DEVELOPMENT PROGRAM. Monthly Progress Report for the Period January 1966. (Aerojet-General Nucleonics, San Ramon, Calif.). Feb. 1966. Contract AT(04-3)-596. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: fission fragment–fuel interaction; operation and performance of fissiochemical gas phase loop; radiation chemistry of systems from both mechanistic and process parameter points of view; fissiochemical fuel development; and fissiochemical synthesis. (P.C.H.)

15915 (DP-MS-66-69) PRODUCTION OF THE TRANSPLUTONIUM ELEMENTS AT SAVANNAH RIVER. Ice, C. H. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 10, 1966. Contract AT(07-2)-1. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments in the production of ^{244}Cm and work that is being done that should lead to more effective recovery of heavier isotopes either as special products or as by-products are reported. The procedure for producing ^{244}Cm, ^{243}Am, and ^{242}Pu by irradiation of ^{239}Pu is described. The Tramex process is used for the purification of Am and Cm. Cross section data related to production of the heavier elements are tabulated. (P.C.H.)

15916 (EUR–3258.e) PRODUCTION OF CARRIER-FREE ^{24}Na BY IRRADIATION OF PURE Mg MATRICES IN POOL-REACTORS. Malvano, R.; Rosa, U.; Grosso, P. (Societe Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). 1966. 20p. Dep. mn.

Carrier-free ^{24}Na can be produced by irradiating high-purity Mg matrices in the fast-neutron fluxes of pool-reactors: 13 to 26 mCi ^{24}Na per gram Mg can be obtained for 4-day irradiations in the RS1 reactor. A radiochemical method based on the electrodeposition of the ^{24}Na activity on a Hg cathode was developed; 0.5-g amounts of Mg can be processed in 4 hours, with nearly quantitative recoveries (93 ± 5%) and high decontamination factors from the matrix (1.5 to 5×10^3). The procedure is described and the results of some production experiments at mCi level are reported. The specific activity obtained when using 99.99% Mg was found to be in the order of 90 Ci/g, and the radiochemical purity about 99.9%, for 4-day irradiations at 2×10^{13} fast neutron/cm^2 sec, taking into account a 15-hour decay (treatment and delivery time). (auth)

15917 (NP–16611) CHARGE CONVERSION OF IRRADIATED RARE-EARTH IONS IN CALCIUM FLUORIDE. Technical Report No. 514. Merz, J. L. (Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics). Dec. 1966. Contract Nonr-1866(16). 351p.

Optical absorption and thermoluminescence measurements were used to study the x-induced reduction of trivalent rare earth ions to the divalent state in CaF_2. Thermoluminescent glow curves for the thirteen available lanthanide ions were measured between 80 and 450°K. These were found to be remarkably similar, with glow peaks occurring at nearly the same temperatures for each of the ions. The activation energies for each of the glow peaks were estimated. High-resolution measurements of the spectra of each glow peak showed that the emission is identical to the fluorescence of trivalent rare earth ions, and determined the site symmetry of the emitting ion. The results of these spectral measurements can be interpreted in a consistent manner. All of the glow emission below room temperature originated from trivalent rare earth ions in cubic sites, while the glow spectra above room temperature indicated tetragonal symmetry. Vibrational side bands were observed for some of the ions. In the model proposed to explain these data, irradiation at 77°K produced divalent rare earth ions and hole centers. Heating allowed a hole to diffuse to the site of a divalent rare earth. The hole and extra electron recombined, leaving an excited trivalent rare earth ion. Decay of this ion to its ground state resulted in the observed thermoluminescence. For the low temperature peaks, the hole center must leave the rare earth in a cubic site. For example, a V_K center would have this property, and the evidence suggests that similar holes trapped at lattice sites are associated with the glow peaks below room temperature. At high temperatures the tetragonal spectra could result from the diffusion of F atoms. Optical absorption bands were found for both the divalent rare earths and the hole centers, and these bands bleached as the crystal was heated. Above 350°K, several of the rare earths exhibited anomalous absorption effects which result from more complicated configurations of holes. Thermoluminescence studies of the isomorphs SrF_2 and BaF_2 are consistent with the model proposed for CaF_2. (auth)

15918 (TID–23710) PRIMARY PROCESSES IN RADIATION CHEMISTRY. Progress Report, February 15, 1966–January 30, 1967. Abrahamson, Edwin W. (Case Inst. of Tech., Cleveland, Ohio. Dept. of Chemistry). Contract AT(11-1)-904. 92p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for theoretical studies on: the spectroscopic basis of carbonyl photochemistry; an iterative extended Hueckel molecular orbital calculation on acetone; ab initio and iterative extended Hueckel molecular orbital calculations on planar and nonplanar states of formaldehyde; spectroscopic basis of eth-

ylene photochemistry; mechanism of transfer of triplet excitation energy in complex molecules; experimental studies on: flash photolysis of kinetics of luminescence decay of excited iodine atoms in the presence of quenching agents and flash photolysis of diazines. Reprints are included for two papers, and manuscripts are included for papers on: photodecomposition and luminescent states of acetone; spectroscopic basis of ethylene photochemistry; mechanism of the collisional transfer of triplet excitation energy; and time resolved emission of electronically excited iodine atoms $I(^2P_{\frac{1}{2}})$. (P.C.H.)

15919 (UJV-1625) ULTRAVIOLET AND VISIBLE SPECTRA OF ELECTRONS, UNSTABLE RADICALS AND IONS. Habersbergerova, A.; Janovsky, I.; Teply, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 108p. Dep. mn.

Data on the uv and visible absorption spectra of electrons, inorganic and organic radicals, and ions formed in radiolysis or photolysis of liquid and solid phases are tabulated. Spectra of electrons measured in water and in aqueous and nonaqueous solutions and those of inorganic glasses irradiated at 77°K are also included. 132 references are given for the period through 1965. (P.C.H.)

15920 (UJV-1703) RADIATSIONNOE OKISLENIE TSIKLOGEKSANA I NEKOTORYKH RODSTVENNYKH UGLEVODORODOV. (Radiation Chemical Oxidation of Cyclohexane and Some Related Hydrocarbons). Sistek, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1966. 14p. (In Russian). Dep. mn.

Radiochemical oxidation of cyclohexane was studied, and yields were determined analytically. A mixture of cis- and trans- decaline (1 : 3) was studied. The effects of side-chain and double bonds on the consumption of O_2 and on the yields of hydrocarbon peroxides, which appear to be derivatives of cyclohexane, were also studied. The material balance of gaseous products was unsatisfactory when only hydrogen and oxygen were considered. (auth)

15921 (KFK-tr-213) BESTIMMUNG DER STRAHLENCHEMISCHEN AUSBEUTE FUER DIE BILDUNG VON TRIPLETTMOLEKUELEN BEI DER RADIOLYSE VON BENZOL. (Determination of the Radiochemical Yield for the Formation of Triplet Molecules in the Radiolysis of Benzene). Samochvalova, L. I.; Krongauz, V. A. Translated into German by Peter Buriks (Kernforschungszentrum, Karlsruhe (West Ger.)), from Dokl. Akad. Nauk SSSR, 168: 154-7(1966). 8p. (In German). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

For determination of the radiochemical yields of triplet molecules from γ irradiation of benzene, the benzene-sensitized cis-trans isomerization of stilbene was used. The dependence of the yield of the cis- and trans-isomers on the stilbene concentration in benzene and cyclohexane was shown. The isomerization increased with concentrations up to 10^{-3}M. At higher concentrations the yields reached a limiting value and remained constant. The limiting value was larger in cyclohexane than in benzene. At stilbene concentrations under 10^{-3}M there was a concurrent interaction between the primary free radicals and the stilbene with radical recombination. At higher stilbene concentrations all primary free radicals appearing in the solvent participated in the isomerization of the stilbene. Radiolysis of stilbene in the presence of vinyl monomers was also studied. At sufficiently high concentrations of the monomer, there was practically no isomerization of the stilbene in cyclohexane. A G(T) value of ~0.4 to 0.5 was obtained for the yield of triplet molecules. (J.S.R.)

15922 ON THE RADIATION STABILITY OF ION EXCHANGERS. Kolditz, L.; Wendt, J. (Humboldt-Univ., Berlin). Z. Chem., 6: 385-6(Oct. 1966). (In German).

The effect of adding ferrocene, cyclopentadienylmanganese tricarbonyl, and vinylanthracene to the matrix of organic ion exchange resins on their stability to ionizing radiation was studied. Resins were made either by addition of ferrocene or the other compounds tested to a monomer (or copolymerization of vinyl derivatives and typical monomers), followed by conversion to the sulfonate or quaternary ammonium compound, or by addition of the ferrocene (or other compound tested) to a functionally substituted monomer. Total compounds prepared numbered 15. Resins were examined in the H^+, Na^+, Cl^-, and $SO_4^=$ forms after irradiation with 4×10^8 to 5×10^8 RAD doses of x rays and accelerated electrons. Exchange capacity, water content, and equilibrium position between H and Na ions were measured. The H^+ and Cl^- forms lost capacity after irradiation; in general the Na^+ and Cl^- forms were the most stable. The water content of irradiated cationic resins contained organic products; that of anionic resins also contained Fe. Results indicated that the radiation stability of strongly acidic cationic exchange resins may be improved, but that of anion exchange resins may not, by the method described. (BBB)

15923 POLYMERIZATIONS AND RADIOCHEMICAL GRAFTING. Chapiro, Adolphe (CNRS, France). Chim. Ind. (Paris), 96: 919-22(Oct. 1966). (In French).

A review of polymerization methods is presented, with note of radical polymerizations and ionic polymerizations. Some attention is devoted to polymerizations in the solid state, particularly of small heterocycles. Techniques of radiochemical grafting are treated: the direct method and the peroxidation method; and industrial applications are listed. Pilot-plant capabilities presently in operation for various materials are reviewed. Studies of direct-method grafting at very low temperatures, in which an ionic mechanism occurs, suggest methods for carrying out procedures in which homopolymerization of one component is negligible. (BBB)

15924 EFFECT OF IONIZING RADIATION ON EPOXY RESINS. Bakaeva, V. P.; Egorova, Z. S.; Karpov, V. L. Dokl. Akad. Nauk SSSR, 170: 868-71(Oct. 1, 1966). (In Russian).

The molecular variations, which occur during irradiation of epoxy resins, were studied. Solid epoxy resins and resins synthesized from epichlorohydrin and diphenylenepropane with a molecular weight of 1000 and an epoxy number of 9 to 12 were studied. Powdered resin specimens were irradiated both in air and in a vacuum at room temperature by a stream of fast electrons with an energy of 200-keV and a current density of 0.0143 ma/cm^2, and by ^{60}Co gamma rays. The radiation doses varied from 20 to 1500 MRAD. The following methods were used: infrared spectroscopy, mass-spectrometric analysis, thermomechanical analysis, and solubility in acetone. The results of these studies showed that breaking of epoxy rings, crosslinking, and destruction occur during irradiation. Crosslinking can be explained by the fact that hydrogen atoms break away from methyl groups to form radicals. This is verified by triplet formation observed in electron paramagnetic resonance spectra during irradiation of diphenylene-propane and epoxy resin. (ATD)

15925 EFFECT OF GAMMA RADIATION ON A NUMBER OF WATER SOLUBLE VITAMINS. Sjoestedt, Monica; Ericson, L.-E. (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 16: 1989-98(1962).

Buffered solutions of some B vitamins (thiamin hydrochloride, riboflavin, niacinamide, biotin, pteroylglutamic acid, and N_5-formyltetrahydropteroylglutamic acid) were irradiated with γ rays from a ^{60}Co source. Residual activity as well as the formation of biologically active breakdown products was studied using microbiological test systems. No microbial growth factors other than the vitamins themselves were detected in irradiated solutions of thiamin, riboflavin, and niacinamide. Biotin-L-sulfoxide was formed on irradiation of biotin and pteroic acid on irradiation of pteroylglutamic acid. Many biologically active breakdown fragments were observed in irradiated solutions of N_5-formyltetrahydropteroylglutamic acid, among them pteroylglutamic acid, N_{10}-formylpteroic acid, pteroic acid, and N_{10}-formylpteroylglutamic acid, as well as 3 chemically unidentified growth factors. It was noted that the degree of destruction as determined spectrophotometrically appeared to be considerably lower than found on microbiological estimation. (BBB)

15926 SYNTHESIS OF AMINO ACIDS BY ^{60}Co GAMMA IRRADIATION. Rai, Tokan; Shinagawa, Mutsuaki (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 4: 42-3(Jan. 1967).

Solutions containing a mixture of 0.05M of fumaric acid and 1M of ammonium hydroxide were irradiated with γ rays from a 500 Ci ^{60}Co source. A dose rate of 3×10^4 R/hr was applied, and the total dose amounted to 3×10^6 R per sample. The irradiated solutions were analyzed for content of amino acid and the amino acid was confirmed to be aspartic acid. The amount of aspartic acid formed was calculated to be 6×10^{-5} moles from 5×10^{-4} moles of fumaric acid. (M.C.G.)

15927 RADIATION-CHEMICAL STABILITY OF TBP IN HYDROCARBON SOLUTIONS. Barelko, E. P.; Solyanina, I. P.; Tsvetkova, Z. I. At. Energ. (USSR), 21: 281-5(Oct. 1966). (In Russian).

The radiolysis of binary mixtures containing tributyl phosphate and aliphatic or aromatic hydrocarbons was studied. The radiochemical stability of the irradiated systems was measured by the yield of acid esters (di- and monobutyl phosphates) and gaseous products and by the Pu and Zr distribution between the irradiated organic phase and the aqueous phase. The dependence of the radiochemical yield of gaseous and acid products on the concentration indicated a deviation from the additivity rule and a transfer of energy from the aliphatic hydrocarbons to TBP. The replacement of aliphatic hydrocarbons by aromatic reduced the radiolytic yield. The influence of aromatic hydrocarbons on the radiochemical stability of TBP was confirmed by data on Zr and Pu distribution coefficient, which was in turn determined by the content of TBP. (R.V.J.)

15928 ELECTRON-SCAVENGER COMPETITION EFFECT IN RADIOLYSIS SYSTEMS. Freeman, G. R.; Holtslander, W. J. (Univ. of Alberta, Can.). Chem. Commun., No. 5, 205-6(Mar. 1967).

It was reported that rate constants of hydrated electron reactions determined from pulse radiolysis studies are sometimes at variance with values of relative rate constants determined from studies of competitive kinetics, and it was found that the apparent relative efficiencies of electron scavengers in gas-phase systems are sometimes different when scavengers are present in pairs than when they are present singly in a given system. Even single scavenger systems involve competitive kinetics, since the electron scavenger must compete with the neutralization reaction. Some studies on methylcyclohexane vapour to which various concentrations of N_2O, SF_6, and DI were added singly and in pairs are described. Relative efficiencies of single scavengers and pairs differed by as much as 20,000-fold. Mechanisms are discussed. Results indicated that the electron affinities of the three scavengers employed were in the order DI > SF_6 > N_2O. It was also noted that in aqueous solution the electron affinity of N_2O is greater than that of CCl_4 or $CHCl_3$. It is hoped that the scavenger competition technique will be useful in determining relative electron affinities of molecules. (UK)

15929 EJECTION OF SURFACE IODINE ATOMS FROM SINGLE CRYSTALS OF POTASSIUM IODIDE SUBJECTED TO (n,γ) REACTIONS. Cairns, J. A.; Thomson, S. J. (Univ. of Glasgow). Inorg. Nucl. Chem. Lett., 3: 107-10(Mar. 1967).

It was shown that (n,γ) reactions invclving the iodine atoms of KI should lead to a series of focused collision sequences in the anion lattice, causing ejection of atomic iodine from the crystal surfaces in certain preferred directions. The problem of detecting these chemically minute amounts of recoiled iodine was solved by having the KI surfaces labeled with ^{131}I. It was demonstrated that ejection is preferentially initiated by thermal neutrons and is accompanied by modest lattice damage. The amount of iodine collected was much greater than could be accounted for on the basis of a simple focused collision sequence mechanism. It was postulated that, following the $^{127}I(n,\gamma)^{128}I$ reaction, recoil is not due entirely to prompt gamma emission and that there is a considerable contribution due to internal conversion and Auger electron emission, producing a high positive charge on the iodine atom, and thereby initiating a number of secondary collision sequences. (UK)

15930 POLYURETHANE ELASTOMERS FROM POST-GRAFTED POLYMER–POLYOL SYSTEMS. Kuryla, William C.; Whitman, Robert D. (Union Carbide Corp., South Charleston, W. Va.). J. Appl. Polymer Sci., 11: 133-6(Jan. 1967).

Certain homopolymer–polyol mixtures, after treatment with a free-radical generating agent or ionizing radiation, produced polyurethane elastomers of nearly twice the stiffness and tensile properties compared to control elastomers made with untreated mixtures. These mixtures included the homopolymers of acrylonitrile and vinyl chloride with a poly(oxypropyl) triol of about 3000 molecular weight as the polyol in each case. The marked improvement in the stiffness and tensile properties of elastomers made with the treated mixtures over those of the untreated controls indicated a grafting process occurring between the polyol and homopolymer upon the generation of free radicals. Grafting could occur by a chain-transfer hydrogen-abstraction mechanism, whereby a free-radical site is generated on both the homopolymer and polyol chains. Coupling of these two free-radical sites would thus result in the establishment of a polymer–polyol graft bond. (auth)

15931 γ-RAY-INDUCED CHEMISORPTION OF OXYGEN ON TITANIA. Spivack, M.; Cropper, W. H.; Dranoff, J. S. (Columbia Univ., New York). Int. J. Appl. Radiat. Isotop., 18: 145-52(Mar. 1967).

Static systems comprised of degassed anatase and oxygen at initial pressures ranging from 38 to 610 μ were irradiated with ^{60}Co γ rays with simultaneous pressure measurement. An increase in the rate of chemisorption at the commencement of irradiation was observed; after prolonged irradiation a nearly steady-state pressure was reached. Data fit an Elovich-type rate equation, with the parameters showing reasonable behavior with variation in the initial pressure. The effect was sensitive to temperature but did not seem related to factors altering the rate of diffusion. (auth)

15932 RADIATION-INDUCED POLYMERIZATION OF NITROETHYLENE. Yamaoka, Hitoshi; Williams, Ffrancon; Hayashi, Koichiro (Kyoto Univ.). Trans. Faraday Soc., 63: 376-81 (Feb. 1967).

A study of radioinduced polymerization of nitroethylene indicated an anionic mechanism involving free ions. By use of hydrogen bromide as an anionic scavenger, the kinetics of polymerization was investigated. G(initiation) is about 3, which is much larger than the value (0.1) obtained for many cationic polymerizations of hydrocarbons. This difference may be explained in terms of the large dielectric constant and high electron affinity of this monomer. By kinetic analysis, the propagation rate constant k_p at 10°C is estimated to be 4×10^7 M^{-1} sec^{-1}. G(initiation) is given by G(–monomer)/degree of polymerization. (auth)

15933 THE RADIOLYSIS OF ETHANOL. VI. HYDROGEN PRECURSORS AT –196°C. Fletcher, J. W.; Freeman, G. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 45: 635-40 (Mar. 15, 1967).

Reactions of trapped (or solvated) electrons in solid ethanol were studied. The following reactions occur at –196°C: $e^-_{solv} + h\nu$ ($\lambda < 5200$ Å) → $H + C_2H_5O^-$; $e^-_{solv} \rightarrow H + C_2H_5O^-$; and $e^- + C_2H_5OH_2^+ \rightarrow H + C_2H_5OH$. The activation energy of the second reaction is roughly 5 kcal/mole. The third reaction occurs with electrons not yet trapped by the medium. Hydrogen atoms appear to be able to abstract from ethanol and to add to propylene at –196°C. (auth)

15934 RADIOLYSIS IN THE ADSORBED STATE. I. CYCLOHEXANE ADSORBED ON SILICA GEL. Sagert, N. H. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Dyne, P. J. Can. J. Chem., 45: 615-27(Mar. 15, 1967). (AECL–2843).

Isotopic labelling techniques were used to study the ^{60}Co γ radiolysis of cyclohexane adsorbed at low coverage on silica gel. Some of the energy absorbed in the silica gel is able to cause decomposition of the hydrocarbon, and the silica gel takes part in the system as a chemical reactant. The effect on the radiolysis of changing the chemical nature of the gel by varying the water content was studied and it is shown that the radiolysis is quite different over gels with low and high water content. These changes are ascribed to the replacement of silanol groups by siloxane groups, with the removal of chemisorbed water. The effect of the additives N_2O and SF_6 was studied in an attempt to determine how much of the reactivity was transferred from the solid by an ionic mechanism. It was concluded that over gels with a high water content more than one half of the reactivity was ionic in nature, whereas over gels with low water content much less was ionic. (auth)

15935 SOLVENT EFFICIENCY IN LIQUID BINARY SCINTILLATORS. Braga, C. Lloyd (Instituto Superior Tecnico, Lisbon). Rev. Port. Quim. (Lisbon), 8: 81-7(1966).

The relative efficiencies of benzene, toluene, p-xylene, and mesitylene as solvents in liquid binary scintillators were studied using as solute 2,5-diphenyloxazole (PPO) with a 10^{-2}M concentration. The relative efficiencies are a function of f_{yx}, the fraction of energy transferred from the solvent to the solute, and of J_{ox}, the rate at which the solvent molecules are excited into the first excited π singlet state. J_{ox} increases in the order benzene, toluene, p-xylene, and mesitylene. f_{yx} increases in the order mesitylene, benzene, toluene, and p-xylene, and the overall efficiency increases in the order benzene, toluene, mesitylene, and p-xylene. (auth)

15936 SPECTROSCOPIC STUDIES OF THE DESTRUCTION PROCESS OF MODIFIED CELLULOSE MATERIALS IRRADIATED BY ULTRAVIOLET RAYS AND γ RADIATION. Savastenko, G. N.; Makhkamov, K.; Ermolenko, I. N.; Virnik, A. D.; Rogovin, Z. A. Zh. Prikl. Khim., 39: 1376-83(June 1966). (In Russian).

Ultraviolet region absorption spectra were obtained for ordinary cellulose ester, a substituted anisole, grafted cellulose, and polyacrylonitrile copolymer. Studies of radiation effects on absorption spectra showed that the intensity of absorption in the ultraviolet region of ordinary cellulose esters and the substituted anisole increased while in the cellulose and polyacrylonitrile it was reduced. Studies of the absorption spectra in the ultraviolet region of the cellulose preparations containing aromatic amino groups and grafted cellulose and polyacrylonitrile following γ irradiation showed that at doses up to 5×10^6 R the absorption spectra of cellulose preparations containing aromatic amino groups remain unchanged while in the grafted cellulose and polyacrylonitrile the absorption in the ultraviolet spectral region was increased. (R.V.J.)

15937 IRRADIATION OF DEXTRAN AND ITS AQUEOUS SOLUTIONS WITH ^{60}Co GAMMA RAYS. Flynn, Joseph H.; Wall, Leo A.; Morrow, William L. (National Bureau of Standards, Washington, D. C.). J. Res. Nat. Bur. Stand., A, 71: 25-31(Jan.–Feb. 1967).

Cross linking predominates over chain scission during the irradiation of concentrated aqueous dextran solutions by cobalt-60 gamma rays in the absence of oxygen. An extensive and long-lived postirradiative viscosity decay is attributed to the agency of hydrogen peroxide formed during the radiolysis of water. Solid dextran primarily degraded upon γ irradiation while dex-

tran triacetate was borderline between dominant scission and cross linking. Both exhibited a postirradiative viscosity decrease when irradiated in the presence of water vapor. Electron spin resonance spectra of dextran in the solid state and in aqueous solution are presented and compared. Spin resonance spectral and chemical evidence concerning the mechanism of cross-linking and postirradiative decay reactions is presented. There is conflicting evidence for the presence of oxyradicals. Speculations are made concerning possible mechanisms of oxyradical formation and their role in the production of ether and peroxy linkages. (auth)

15938 KINETICS OF REACTIONS OF THE HYDRATED ELECTRON: APPARENT CONFLICTS BETWEEN DATA FROM PULSE RADIOLYSIS AND STEADY-STATE EXPERIMENTS. Buxton, G. V. (Univ. of Leeds, Eng.); Dainton, F. S.; Thielens, G. Chem. Commun., No. 4, 201-2(Feb. 22, 1967).

Kinetics of the reactions of two solutes with hydrated electrons was studied in gamma-irradiated aqueous solutions containing N_2O or H_2O_2 and Cd^{2+}, Co^{2+}, or Ni^{2+}. Rate constants for the reactions are tabulated. (J.G.B.)

15939 A NEW WAY TO MAKE PURE ^{141}Ce. O'Brien, H. A. Jr.; Eldridge, J. S. (Oak Ridge National Lab., Tenn.). Nucleonics, 25: No. 2, 41-3(Feb. 1967).

A method was developed for the production of radiochemically pure ^{141}Ce from ^{139}La by the following reactions: $^{139}La(n,\gamma)^{140}La \xrightarrow{\beta^-} {}^{140}Ce(n,\gamma) \rightarrow {}^{141}Ce$ or $^{139}La(n,\gamma) \rightarrow {}^{140}La(n,\gamma) \rightarrow {}^{141}La \xrightarrow{\beta^-} {}^{141}Ce$. One hundred-mCi amounts of pure ^{141}Ce were obtained from 1-g La targets. ^{141}Ce was also prepared by neutron irradiation of praseodymium. Half-life measurements were made on 2 separate ^{141}Ce samples and a value of 32.38 ± 0.02 days was obtained. (M.C.G.)

15940 RADIO-CHEMICAL EFFECTS IN THE WOOD–PULP–MONOMER SYSTEM. Varga, Stefan; Kosik, Martin (Slovak Polytechnic Inst., Bratislava). Jad. Energ., 13: 62-9(Feb. 1967). (In Czech).

Modification of wood pulp by radioinduced polymerization is discussed. Radiation effects on cellulose, lignine, and wood pulp are described. It is shown that the initial radioinduced combination of wood pulp and vinyl monomers is based on the properties of the polymer and basic monomer components and can be further induced by irradiation of the impregnated pulp. An analysis of the chemistry of wood-pulp polymerization is given and the physico-chemical and mechanical properties of the irradiated wood pulp–polymer system are described. (tr-auth)

15941 RADIATION CHEMISTRY OF THE AQUEOUS NITRATE SYSTEM. I. γ RADIOLYSIS OF DILUTE SOLUTIONS. Daniels, Malcolm; Wigg, Eric E. (Oregon State Univ., Corvallis). J. Phys. Chem., 71: 1024-33(Mar. 1967).

The γ radiolysis of the aqueous nitrate system was investigated as a function of dose, intensity, temperature, concentration, and pH, with oxygen, nitrite, hydrogen, and hydrogen peroxide as scavengers. In neutral solution a simple seven-stage mechanism was deduced which quantitatively accounts for the results. The rate-constant ratios $k(e^- + O_2)/k(e^- + NO_3^-)$ and $k(OH + H_2)/k(OH + NO_2^-)$ were evaluated as 2.5×0.2 and 0.8×10^{-3}, respectively, and only two rate constants of this mechanism remain unknown. Yields of primary products were deduced or measured, and it was shown that stoichiometry was obtained by including $g(O_2) = 0.1$. The mechanism in alkaline solution changed owing to the ionization of OH and the subsequent reactions of the O^- species. It is shown that O^- reacted rapidly with H_2O_2, $k(O^- + H_2O_2) = 1.3 \times 10^{10}$ $\underline{M}^{-1}$ sec^{-1}. Oxygen was found to compete with H_2O_2 for O^- and also to react with NO_2^-. The complete mechanism in alkaline solution involved six reactions; for these only three rate constants are unknown and the ratio of two of these was determined, $k(NO_2^- + O_2)/k(NO_2^- + H_2O) = 2 \times 10^5$. (auth)

15942 THE RADIOLYSIS OF CONCENTRATED NEUTRAL SODIUM PERCHLORATE AQUEOUS SOLUTIONS. Konstantatos, J.; Katakis, D. (Democritos Nuclear Research Center, Athens). J. Phys. Chem., 71: 979-83(Mar. 1967).

The products of decomposition of ClO_4^- in the γ radiolysis of neutral concentrated aqueous solutions of $NaClO_4$ are mainly ClO_3^-, ClO_2^-, and possibly some Cl^-. A small amount of ClO_2 was also detected, which decreased further by a postirradiation reaction. The ClO_3^- and ClO_2^- yields were found to be proportional to the $NaClO_4$ molar concentration up to 8$\underline{M}$. Bromide ion decreased the chlorate and increased the chlorite yields. The formation of H_2O_2 in air-saturated solutions was also influenced by the $NaClO_4$ concentration, the (H_2O_2) vs. dose curves resembling, however, those obtained in pure neutral water. (auth)

15943 THE RADIOLYSIS OF THIOPHENOL AND ITS MIXTURES WITH BENZENE AND BENZENE-d_6. Lunde, Gulbrand; Hentz, Robert R. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 71: 863-9(Mar. 1967). (COO–38-502).

G values obtained in γ irradiation of liquid thiophenol at room temperature are as follows: H_2, 4.2 ± 0.1; $(C_6H_5S)_2$, 4.6 ± 0.1; C_6H_6, 1.4 ± 0.1; H_2S, 0.44 ± 0.03; and $(C_6H_5)_2S$, 0.049 ± 0.004. Cleavages of C_6H_5S-H and C_6H_5-SH bonds were suggested as the major modes of decomposition with some contribution from a process that yields molecular hydrogen. Abstraction from the C_6H_5S-H bond to form H_2 was considered the almost exclusive fate of H in pure thiophenol. Like the large $G(H_2)$ in pure thiophenol, the $G(H_2)$ results obtained in γ irradiation of benzene–thiophenol mixtures are a novelty in the radiation chemistry of aromatic systems; these $G(H_2)$ values lie appreciably above the law-of-averages line in a conventional electron-fraction plot. Results on $C_6H_5SH-C_6D_6$ mixtures indicated a sensitization of thiophenol decomposition by energy transfer from benzene; such transfer appeared essentially complete at ~0.2$\underline{M}$ thiophenol. The behavior of H_2 and HD yields at higher concentrations of thiophenol was determined by the competition between abstraction from thiophenol by hydrogen atoms to give hydrogen and addition of hydrogen atoms to the benzene ring. The data on HD yields give $k_1/k_2 = 22 \pm 1$ and a lower limit for the yield of D atoms from pure C_6D_6 of $G_D^0 = 0.085$. (auth)

15944 RADIOLYSIS YIELDS FROM γ-IRRADIATED LIQUID METHANOL CONTAINING NITROUS OXIDE AND THE EFFECT OF ACID. Seki, Hiroshi; Imamura, Masashi (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Chem., 71: 870-5 (Mar. 1967).

The effect of nitrous oxide on the product yields from γ-irradiated liquid methanol in the presence and absence of sulfuric acid was studied. On addition of nitrous oxide to neutral methanol, $G(H_2)$ decreased and $G(N_2)$ increased sharply in the low concentration range of nitrous oxide, whereas all other yields showed little or no variation in the entire concentration range of nitrous oxide studied. Addition of sulfuric acid to nitrous oxide solutions gave an increase in $G(H_2)$ and a decrease in $G(N_2)$. The result can be treated as a competition of solvated electrons for nitrous oxide and hydrogen ions, $k(e^-_{solv} + H^+)/k(e^-_{solv} + N_2O) = 3$. It was concluded that the yield of solvated electrons produced by γ irradiation is 2.0, and a "true" $G(H_2)$ from γ-irradiated liquid methanol is 5.4. Disagreement in $G_{e^-_{solv}}$ between the present and other values reported is discussed. (auth)

15945 INFRARED SPECTROSCOPY IN THE INVESTIGATION OF RADIATION INDUCED GRAFT COPOLYMERIZATION. DasGupta, Sharda (Atomic Energy of Canada Ltd., Ottawa). Can. Spectros., 12: 16-19(Jan. 1967).

Infrared spectroscopy was found to be a valuable radioinduced graft copolymerization reactions. Gamma radiation when absorbed in significant quantities has a profound effect on the molecular structure of materials and can, under controlled conditions be made to initiate or promote a multitude of chemical reactions. In order to find the best conditions for the synthesis of specific graft copolymers with the required properties, it is necessary to understand the mechanism of the reactions involved, to obtain proof of the formation of grafts and to study the structure of the materials formed. The use of infrared spectroscopy for such studies in the field of natural and synthetic fibers, graft copolymers, radiation resistant greases and lignin resins was discussed. (auth)

15946 RADIATION CHEMISTRY OF LIQUID METHANE. Gillis, Hugh A. (Mellon Inst., Pittsburgh. Western Reserve Univ., Cleveland). J. Phys. Chem., 71: 1089-97(Mar. 1967). (RRL–2310-186).

Liquid methane at 112°K was irradiated by ^{60}Co γ rays in the pure state and with small amounts of added ethylene or propylene. The effects of these olefins on products up to C_6 can be interpreted by a simple hydrogen atom scavenging mechanism. The ratios k_{dis}/k_{comb} were estimated to be 1.0 for ethyl plus ethyl, 3.6 for isopropyl plus isopropyl, and 0.9 for methyl plus isopropyl. These are all much higher than gas-phase results. The isotope effect in the disproportionation reaction was found to be small ($k_H/k_D \simeq 1.1$). In experiments with CH_4-CD_4 solutions, the isotopic composition of the product ethane showed that the methylene radical was an important intermediate. In an experiment with a $CD_4-C_3H_8$ solution, a product of the ion–molecule reaction between CD_5^+ and C_3H_8, for the occurrence of which there is good evidence in the gas phase, was looked for and not found. (auth)

15947 PRIMARY PROCESSES IN THE FORMATION OF HYDROGEN ATOMS IN THE RADIOLYSIS OF WATER VAPOR. Johnson, G. R. A.; Simic, M. (The Univ., Newcastle upon Tyne, Eng.). J. Phys. Chem., 71: 1118-23(Mar. 1967).

In the radiolysis of $D_2O + C_3H_8$ mixtures, the energy absorbed by each component contributed to the formation of D atoms. The yield due to the energy absorbed by C_3H_8 ($G(D)_D^0 = 4.6 \pm 0.3$) is explained in terms of proton transfer from propane positive ions to D_2O and

subsequent formation of D atoms by neutralization of the hydronium ion produced. In the presence of N_2O or of SF_6, which act as electron scavengers, $G(D)^0_0 = 0$ showing that D atoms were not formed when hydronium ions were neutralized by the negative ions from N_2O and SF_6. The yield due to the energy absorbed by D_2O was $G(D)^0_w = 7.6 \pm 0.4$ in the absence and $G(D)^0_w = 4.9 \pm 0.4$ in the presence of electron scavengers. It was concluded that neutralization of hydronium ions by electrons gives D atoms with a yield corresponding to $G = 2.7 \pm 0.8$, and that D atoms are also formed ($G = 4.9 \pm 0.4$) by reactions that do not involve hydronium ion neutralization. (auth)

15948 RADIOLYSIS OF AQUEOUS SULFURIC ACID SOLUTIONS OF METHANOL. Sibirskaya, G. K.; Pikaev, A. K. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 190-2(Jan. 1967). (In Russian).

Radiochemical yields of ethylene glycol, formaldehyde, hydrogen peroxide, and hydrogen were measured at various methanol concentrations in 0.4 M H_2SO_4. Radiolytic techniques were developed for the system and the ratio of the recombination rate constant and disproportionation of the free radicals, CH_2OH, were estimated. (R.V.J.)

15949 REACTION INTERMEDIATES IN THE RADIOLYSIS OF ALKYL IODIDES IN 3-METHYLPENTANE GLASS AT 77°K. Claridge, R. F. C.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-32. J. Amer. Chem. Soc., 89: 510-16(Feb. 1, 1967).

At least six metastable species with absorption maxima in the 3000 to 8000 Å range resulted from the γ-irradiation of dilute solutions of alkyl iodides in 3-methylpentane (3-MP) glass at 77°K and below. The predominant species immediately after irradiation at 20 or 77°K decayed within minutes at 77°K or above, accompanied by a sequence of growth and decay of other species. These are distinguished by differences in their stability with respect to aging and photobleaching and by the effect which charge scavengers have on their yields. Five of the species involve the alkyl radicals from the RI as well as the I atom, since only one peak is produced when HI is radiolyzed in 3-MP at 77°K. None of the same maxima were observed when the solute was a bromide or chloride. The sixth species, which grows following irradiation, appears to be I_2^-. All ten iodides tested gave peaks consistent with an RI^+ species which converted to an $(RI)_n^+$ species. γ-Irradiated solutions of alkyl iodides in methyltetrahydrofuran were transparent in the 3000 to 8000 Å region, indicating that charge is stabilized on the solvent, or that $(RI)_n$ clusters are precluded by the polar nature of the solvent, or both. $G(I_2)$ from C_4H_9I and $G(CH_4)$ from CH_3I in 3-MP at 77°K were both greatly reduced by 10^{-2} mf CCl_4, consistent with the conclusion that their formation includes a dissociative electron capture step. Photolysis of HI or of n-C_4H_9I in 3-MP at 77°K produced neutral species absorbing in the 4000 Å region which increased in concentration on standing at 80°K following photolysis. (auth)

15950 γ RADIOLYSIS OF OLEIC ACID. Howton, David R.; Wu, Guey-Shuang (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 89: 516-25(Feb. 1, 1967).

Exposure of oleic acid in the absence of air to ^{60}Co γ rays (in agreement with findings in earlier investigations involving other types of ionizing radiation) resulted in polymerization, cis-trans isomerization, decarboxylation, and hydrogenation, in order of decreasing extensiveness. Hydrocarbons resulting from decarboxylation are primarily of chain length C_{17}; others of higher molecular weight are believed to be derived from dimers by secondary reaction. Contrary to conclusions reached in earlier work, the major hydrocarbon is cis-8-heptadecene, the "straightforward" decarboxylation product of oleic acid. Decarboxylation, which occurred independently of concurrent events (hydrogenation and isomerization) affecting the center of unsaturation, is believed to be initiated by loss of an electron from the carboxyl group, followed by events in which the hydrogen-bonded association dimers of the acid play an important role. Dimers, apparently largely doubly unsaturated and cross-linked at carbon atoms adjacent to the double bonds, are believed to arise largely via coupling of allylic radicals produced both by hydrogen-atom abstraction and by C–H bond homolysis. Higher polymers were produced by secondary reactions. (auth)

15951 MECHANISM OF THE EFFECT OF IONIZING RADIATION ON CERTAIN ENZYMATIC REACTIONS (TYROSINE-TYROSINASE SYSTEM). Arnaud, Yves (CEA-CEN, Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 63: 1564-8(Nov.-Dec. 1966). (In French).

Changes in the quaternary structure and enzymatic activity of tyrosinase or polyphenoloxydase(PPO) after gamma irradiation were studied. The rate of oxidation of tyrosine by PPO after irradiation of the complete system, tyrosine-PPO increased up to 200% with a dose of 2500 RAD. When irradiation was performed on dry protein alone, the inactivation curve observed suggested a direct action of gamma rays. Addition of irradiated tyrosine (substrate) to nonirradiated PPO induced an activation as high as that observed by irradiation of the complete system. The radiochemical reaction in the substrate constitutes the initial radiation effect on the enzymatic mechanism. (J.G.B.)

15952 PRODUCTS OF γ-RAY INDUCED TELOMERIZATION REACTION BETWEEN ALLYL ALCOHOL AND CARBON TETRACHLORIDE. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Zasshi, 88: 212-15(Feb. 1967). (In Japanese).

The 1:1-telomer, 2,4,4,4-tetrachlorobutanol, produced by γ-induced telomerization reaction between allyl alcohol and carbon tetrachloride, was isolated without decomposition by distillation under reduced pressure. But, the 2:1-telomer was very unstable and dehydrochlorinated easily. The dehydrochlorinated product was shown to be 4 (β,β,β-trichloroethyl) tetrahydrofurfuryl alcohol. This compound was also obtained in high yields by treating telomers of allyl carboxylates in methanol with hydrochloric acid and/or with potassium hydroxide. This method, was used to determine the production ratio of 2:1-telomers to 1:1-telomers of higher boiling allyl carboxylates. The results obtained showed that allyl carboxylates with bulkier carboxyl residues had lower values of telomer production ratios. From relations between production ratios and velocities of double bond consumption, the reaction mechanism was discussed. (auth)

15953 ANIONIC POLYMERIZATION OF ACRYLONITRILE INITIATED BY GAMMA RAYS IN THE VICINITY OF ITS VITREOUS TRANSITION POINT. Chapiro, Adolphe; Perec, Liliana (CNRS, Bellevue, France). Compt. Rend., Ser. C, 264: 285-7 (Jan. 16, 1967). (In French).

Mixtures of acrylonitrile and dimethylformamide form a glass at low temperatures for proportions of monomer between 25 and 60%. The irradiation of these mixtures at –196°C leads, after fusion under vacuum, to an important quantity of polymer. This polymerization, which is inhibited by acetone, methanol, and water, seems to proceed by an anionic mechanism. If the fusion of the irradiated mixture is effected in the presence of acetone, it does not form the polymer. From irradiations effected at different temperatures it was shown that polymerization is produced only in a very narrow temperature range on both sides of the vitreous transition. (tr-auth)

15954 INVESTIGATION IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XV. THE COPOLYMERIZATION OF VINYL CHLOROACETATE AND VINYL LAURATE. Hardy, Gyula; Boros-Gyevi, Edith (Research Inst. for the Plastics, Budapest). Acta Chim. Acad. Sci. Hung., 50: 319-24(1966).

The gamma-induced liquid-phase copolymerization of vinyl chloroacetate and vinyl laurate was characterized by the values $r_1 = 0.87$ and $r_2 = 0.65$. In the solid state the two components crystallized separately and one after the other. In the solid state, polymerization rate was highest for pure vinyl chloroacetate. In a mixture containing only a small quantity of vinyl laurate the rate of copolymerization in a thoroughly supercooled liquid phase was twice as high as in the solid state. (auth)

15955 STRUCTURAL ELUCIDATION OF ORGANIC COMPOUNDS BY ELECTRON BURNING. PART III. ELECTRON BURNING OF ESTERS. Schildknecht, H.; Enzmann, F. (Univ., Heidelberg). Z. Anal. Chem., 225: 14-23(1967). (In German).

The electron "burning" of benzyl benzoate and benzyl succinate in tritium water yields the corresponding acids and benzaldehyde. Since the same products are obtained in tritium gas, the process is not a saponification. Phenyl salicylate also gives salicylic acid in addition to unlabelled phenol. Methyl β-resorcylate is probably first fragmentated to resorcylic acid, which cannot be detected because it is decarboxylated under these conditions. But it is possible to identify resorcinol. Especially interesting is the electron "burning" of tributyrin, which is degraded to dibutyrin, monobutyrinl glycerol, and butyric acid. In this case a second fragmentation-process was observed forming triacetin; acetic acid and glycerol are the degradation products. (auth)

15956 PULSE RADIOLYSIS OF SULFURIC ACID AQUEOUS SOLUTIONS. Pikaev, A. K.; Zolotarevskii, V. I. (Inst. of Physical Chemistry, Academy of Sciences, USSR. Inst. of Electrochemistry, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Khim., No. 1, 188-90(Jan. 1967). (In Russian).

A short life optical absorption (with a maximum at 450 mμ) produced by the radical HSO_4 (or SO_4^-) was discovered by pulse radiolysis of irradiated sufuric acid aqueous solutions. The molar coefficient of extinction of the product (~1000 l/mole cm) and rate constant of the reaction between OH radical and HSO_4^- ion (or SO_4^{2-}) (~10^6 l/mole sec) were found. (R.V.J.)

15957 REACTIONS OF HYDROGEN AND TRITIUM ATOMS WITH CARBON AT 77°K. Gill, P. S.; Toomey, R. E.; Moser, H. C. (Kansas State Univ., Manhattan). Carbon, 5: 43-6(Feb. 1967).

Hydrogen containing tritium was atomized at a hot tungsten filament, and the atoms were reacted with carbon (graphite, lamp black, and diamond) at 77°K. At pressures low enough to allow a collision-free path for the hydrogen atoms between the filament and the surface of the carbon, CH_4, C_2H_6, C_3H_8, iso-C_4H_{10}, n-C_4H_{10} were produced and an unidentified higher molecular weight compound was extracted by benzene from graphite. Only CH_4 and C_2H_6 were formed with hydrogen atoms moderated to 77°K by an inert helium atmosphere. Graphite was more reactive than diamond or lamp black. The distribution of products was found to vary with filament temperature, hydrogen pressure, and length of reaction time. A sequence of consecutive reactions is proposed as the mechanism for the formation of the hydrocarbons. (auth)

15958 ELECTRON SPIN RESONANCE OF IRRADIATED SINGLE CRYSTALS OF SODIUM AND POTASSIUM 1-OXIMINOPROPIONATES. Hayashi, Hisaharu; Itoh, Koichi; Nagakura, Saburo (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 284-93(Feb. 1967).

ESR studies were made on single crystals of sodium 1-oximinopropionate (2-hydroxyiminopropionate) irradiated at −196°C and at room temperature. The principal values and axes of the g and hyperfine tensors of the trapped radicals were determined. Analysis of the observed data indicated that the σ-electron radicals $CH_3C(COO^-)=NO\cdot$ are trapped at −196°C and at room temperature. It was found that the electronic structures of the trapped radicals at these two temperatures are essentially the same, but that the environments of the radicals are very different. After the crystal was heated at 50°C for a week, the σ-electron radical vanished and the π-electron radicals, $CH_3C(OH)(COO^-)NHO\cdot$ and $CH_3CR'-(COO^-)NRO\cdot$, appeared. The former may be formed in the solid state by adding a crystal water molecule to the unsaturated radical. The trapped radical in irradiated single crystals of potassium 1-oximinopropionate (2-hydroxyiminopropionate) were also studied at room temperature and after having been heated at 50°C. They are the σ-electron radical and the π-electron radical, respectively, with structures similar to those of the sodium salt. The radical pairs were observed in irradiated single crystals of the sodium salt at −196°C. (auth)

15959 MEASUREMENT OF ELECTRON-DIFFRACTION INTENSITY BY A DIGITAL VOLTMETER. Morino, Yonezo; Kuchitsu, Kozo; Fukuyama, Tsutomu (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 423-4(Feb. 1967).

The gamma-radioinduced polymerization of 2-methyl-propene, 3-methyl-1-butene, and 4-methyl-1-pentene was investigated. Results of tests on the polymers' sensitivity to traces of water are tabulated. Radioinduced copolymerization of 3-methyl-1-butene and 4-methyl-1-pentene with SO_2 was also carried out and their reactivities compared. The rates of polymerization and molecular weights of the polymer from 2-methylpropene were much higher than the values obtained for the other two compounds; also, they were much more sensitive to traces of water. (J.G.B.)

15960 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. DIXIEME SERIE. (The Chemical and Biological Action of Radiations. Tenth Series). Haissinsky, M. Paris, Masson et Cie Editeurs, 1966. 331p.

Four monographs on the chemical and biological action of radiations are compiled. These monographs discuss the hydrated electron, reaction velocities of free radicals produced by radiolysis of water, radiolysis of liquid hydrocarbons, and solid-state polymerizations induced by radiation. Individual abstracts of the monographs were prepared. (J.S.R.)

For abstracts of individual papers see: 15961–15964.

15961 HYDRATED ELECTRON. Hart, Edwin J. (Argonne National Lab., Ill.). pp 1-88 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie Editeurs, 1966.

The history of the detection of hydrated electrons in irradiated water is outlined. The analytical and preparative techniques available for analysis and determination of the physical and chemical properties of the hydrated electrons are discussed. The techniques of pulse radiolysis are confined to the consideration of the spectrophotometric method only where the optical absorption of the hydrated electron was followed as a function of time. A brief summary of the physical properties of the hydrated electron is given, followed by some speculations on its structure based on the structure of the ammoniated electron. Reactions of the hydrated electron with water and with inorganic, organic, and biologically important compounds are treated. (J.S.R.)

15962 RATES OF REACTION OF THE FREE RADICALS PRODUCED BY RADIOLYSIS OF WATER. Ferradini, Christiane (Laboratoire Curie, Paris). pp 89-124 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie Editeurs, 1966. (In French).

Methods used for measurement of the reaction rates of free radicals produced by water radiolysis are outlined. These include the method of competition, the use of pulsed radiation sources with variable frequencies, direct measurement of intermediaries, and use of free radicals of nonradiolytic origin. The reaction rates of OH^-, H^+, HO_2^-, and O_2^- free radicals are discussed, and measured values of the velocity rates are tabulated. (J.S.R.)

15963 RADIOLYSIS OF LIQUID HYDROCARBONS. Hardwick, T. J. (Gulf Research and Development Co., Pittsburgh). pp 125-85 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie Editeurs, 1966.

The sequence of events following the passage of an ionizing particle in a liquid hydrocarbon is described on a priori grounds. A description of experimental results from alkane radiolysis is given. The mechanisms for formation of intermediate products are discussed with reference to the sequence of events following the passage of an ionizing particle. Olefins, on absorption of ionization radiation, form products by a free-radical mechanism, by an ionic mechanism, or by both. The radiolysis of aromatic hydrocarbons, more complex than that of alkane or olefin is considered. Descriptive material on radiolysis of deuterated hydrocarbons, isotope effects in hydrocarbon radiolysis, and energy transfer is presented. (J.S.R.)

15964 POLYMERIZATION IN THE SOLID STATE INITIATED BY RADIATIONS. Chapiro, Adolphe (CNRS, Bellevue, France). pp 187-312 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie Editeurs, 1966. (In French).

General characteristics of polymerization in the solid phase were examined by clearing away the different factors that seem to intervene in one or several stages of the reaction. The particular objects of extensive experimental studies were then examined in detail. These are the vinyl monomers, heterocyclic monomers, and monomers with carbonyl and nitrile functions. The different aspects of these reactions, which can contribute to radiation chemistry, are emphasized. (J.S.R.)

15965 SELF-IRRADIATED CONTACT MATERIAL SYSTEM FOR CARRYING OUT CHEMICAL REACTIONS. (to Mobil Oil Corp.). British Patent 1,057,396. Feb. 1, 1967. Priority date Sept. 14, 1962, United States.

A method for performing a radioinduced chemical reaction consists of contacting the chemical reactants with a radioactive solid contact material. The solid contact material is formed with a stable inactive nuclide that is capable of yielding a radionuclide on thermal-neutron activation and is then irradiated in a neutron flux. The radioactive compact is removed from the neutron flux prior to contact with the chemical reactants. (B.L.M.)

15966 PROCESS FOR THE PREPARATION OF A RADIOACTIVE SOURCE. Henry, Robert; Levy, Viviane; Tournier, Jean (to Commissariat a l'Energie Atomique). British Patent 1,057,404. Feb. 1, 1967. Priority date Mar. 10, 1964, France.

A process is described for the production of a ^{210}Po source by the neutron irradiation of a Bi–Mg alloy containing less than 85.1 wt % Bi, preferably 80 wt %. At Bi concentrations approaching 85.1 wt %, the product contains a proportion of the eutectic mixture $Bi-Mg_3Bi_2$, which melts at 260°C, and does not permit utilization of the source at high temperatures. (B.L.M.)

15967 RADIATION RESISTANT MINERAL OILS. Schneider, Norbert (to British Petroleum Co. Ltd.). British Patent 1,055,047. Jan. 11, 1967. Priority date Sept. 10, 1964, Germany.

A process for the preparation of radiation-resistant lubricating and heat-transfer oils comprises hydrocatalytically treating an aromatic mineral oil fraction at a temperature between 350 and 480°C in the presence of a catalyst and in the presence of H_2 under a pressure of 20 to 40 atm. Suitable catalysts are W/NiS, Co and Mo oxides, or Co, Mo, and Fe oxides supported on alumina. (B.L.M.)

15968 RADIATION RESISTANT MINERAL OILS. Schneider, Norbert (to British Petroleum Co. Ltd.). British Patent 1,055,046. Jan. 11, 1967. Priority date Sept. 10, 1964, Germany.

A mineral oil resistant to the effects of ionizing radiation was prepared by pyrolysis of a mineral oil fraction rich in aromatics at a temperature between 360 and 480°C. (B.L.M.)

Radiochemistry

15969 ACIDITY OF HYDROCARBONS. XXIII. BASE-CATALYZED PROTON EXCHANGE OF 1H-UNDECAFLUORO-BICYCLO[2.2.1]HEPTANE AND THE ROLE OF CARBON–FLUORINE NO-BOND RESONANCE. Streitwieser, A. Jr.; Holtz, David (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 692-3(Feb. 1, 1967).

The base-catalyzed exchange rates for tritium incorporation in 1H-undecafluoronorbornane (I) were measured in methanol-t with sodium methoxide as catalyst in the temperature range –23 to 74°C. Rate constants are tabulated. The extreme reactivity of (I) was demonstrated by complete isotopic exchange in less than 4 min at –23° with 0.001 N base. Results indicated that hyperconjugation effects are not important in stabilizing fluoroalkyl anions. (J.G.B.)

15970 ACIDITY OF HYDROCARBONS. XXIV. PROTON EXCHANGE OF 9-SUBSTITUTED FLUORENES WITH METHANOLIC SODIUM METHOXIDE. STABILIZATION OF 9-TRIFLUOROMETHYLFLUORENYL ANION BY INDUCTIVE EFFECTS. Streitwieser, A. Jr.; Marchand, Alan P.; Pudjaatmaka, A. H. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 693-4(Feb. 1, 1967).

Protodetritiation kinetics were run in methanolic sodium methoxide solutions of several 9-substituted 9-tritiated fluorenes including that from 9-trifluoromethylfluorene. Results indicated that the trifluoromethyl group does not produce reactivity significantly in excess of that expected from inductive effects alone. (J.G.B.)

15971 THE NUCLEAR CHEMICAL SIGNIFICANCE OF ABSOLUTE RADIOACTIVE MEASUREMENTS. II. A NEW METHOD FOR THE PREPARATION OF SECONDARY RaD (^{210}Pb) STANDARDS AND POSSIBILITIES OF THEIR APPLICATION. Imre, Lajos; Fabry, Gyula (Kossuth Univ., Debrecen, Hungary). Acta Chim. Acad. Sci. Hung., 50: 245-61(1966).

The half-life of RaD (^{210}Pb) was determined by α counting, by β counting, and by comparing the β activity of glass vials of different age, containing known amounts of radon gas, and evaluating the data as the function of time. The following results were obtained: $\lambda_D = 3.08 \times 10^{-2}$ year^{-1} by alpha counting; $\lambda_D = 2.95 \times 10^{-2}$ year^{-1} by beta counting; and $(\lambda_D)_{class.} \simeq 3.1 \times 10^{-2}$ year^{-1} by the third method. Comparison with the β radiation from ^{234}Th and ^{234}Pa nuclides showed that the difference between half-life determination is only partly explicable by the divergence from the Fermi-curve. From the results a method is proposed for the preparation of RaD standards. (auth)

15972 SIMULTANEOUS PREPARATION OF PRECIPITATE AND PLANCHET SAMPLES FOR RADIOACTIVE COUNTING. Beetch, E. B.; Paulson, B. A. (Mankato State Coll., Minn.). Chem. Anal., 56: 35(Jan. 1967).

An apparatus was designed to separate a precipitate and filtrate and prepare both for radioactive counting. The apparatus consisted of a bell jar and a stainless-steel vacuum funnel with a demountable barrel for positioning of the filter-paper disk and a planchet support. (P.C.S.)

15973 ADVANCES IN INORGANIC CHEMISTRY AND RADIOCHEMISTRY. VOLUME 9. Emeleus, H. J.; Sharpe, A. G. (eds.). New York, Academic Press, 1966. 398p. $15.50.

The contents of the ninth volume of Advances in Inorganic Chemistry and Radiochemistry are liquid–liquid extraction of metal ions, nitrides of metals of the first transition theory, pseudohalides of group IIIB and IVB elements; stereoselectivity in coordination compounds; heterocations; and the inorganic chemistry of tungsten. (D.H.M.)

Separation Processes

Refer also to abstracts 15895, 15915, 16634, and 17537.

15974 (UJV–1573) EXTRACTION OF ALKALI-EARTH METALS BY ORGANIC SOLVENTS. Pivonkova, M.; Kyrs, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 22p. Dep. mn.

A summary of literature data on the extraction of alkaline earth metals by means of organic solvents is presented. Extractions using organophosphoric compounds, oxines, thenoyltrifluoroacetone (TTA), other "non-selective" agents, selective agents for calcium and strontium, and strong polar solvents are discussed. (D.H.M.)

15975 (MLM-1375(tr)) THE FRACTIONING TUBE. XVII. PREPARATION OF THE RARE ISOTOPE ^{21}Ne IN A PURITY OF 99.6 PERCENT. Clusius, K.; Huber, M.; Huerzeler, H.; Schumacher, E. Translated for Mound Lab., Miamisburg, Ohio, from Z. Naturforsch., 11a: 702-9(1956). 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Starting with 60 liters of Ne, a concentrate is obtained in 5 steps which contains a maximum of 12.6% ^{21}Ne, whereas ordinary neon has only 0.257% of this isotope. The concentration distribution of the three isotopes ^{20}Ne, ^{21}Ne, and ^{22}Ne in the fractionating apparatus is measured and found in agreement with theory. By addition of a $CD_4/CD_3H/CH_2D_2$ mixture in a 175 day experiment, it was possible to remove ^{22}Ne, 3.95% ^{21}Ne, and 3.15% ^{20}Ne to such an extent that there remains a Ne of 99.6% ^{21}Ne containing only 0.2% each of ^{22}Ne and ^{20}Ne. This enrichment corresponds to a fractionation factor of 96,700. The purity of the gases obtained is illustrated by hyperfine structure photographs at the line 5852 Å. Technical data and discussion on the advantages of the auxiliary gas are appended. (P.C.H.)

15976 (ORNL-tr–1435) ENRICHMENT OF ^{12}C AND ^{13}C BY GAS-PHASE CHROMATOGRAPHY OF CO ON MOLECULAR SIEVES. Blanc, C. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from report No. 59 of the Societe Nationale de Petroles d'Aquitaine. 54p. Dep. mn. JCL $5.60 fs, $1.85 mf.

An original method is described for enrichment of ^{12}C and ^{13}C by gas chromatography of CO on a molecular sieve. A model for the separation is given. Enrichments of from 1 to 9% were obtained when the temperature was decreased from 100 to –30°C. Besides the temperature, the column length strongly affected the enrichment factor. A systematic study of the different parameters entering into chromatography made it possible to optimize the enrichment and obtain an enrichment of 30%. (92 references). (P.C.H.)

15977 SOLUBILITIES OF Pu(III), Am(III), AND Cm(III) OXALATES. Burney, G. A.; Porter, J. A. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Inorg. Nucl. Chem. Lett., 3: 79-85(Mar. 1967). (DP-MS-66-74).

Measurements were made of the solubilities of Pu(III), Am(III), and Cm(III) oxalates in nitric acid–oxalic acid solutions. These oxalates are useful in the separation and purification of Pu, Am, and Cu. Increasing the oxalic acid concentration decreased the solubility of plutonium oxalate except at low nitric acid concentrations. In 0.1 and 0.25M nitric acid solutions the solubility of americium oxalate decreased initially with increases in oxalic acid concentration and then increased. This effect was not noted at higher nitric acid concentrations. Curium oxalate was slightly less soluble than americium oxalate at a given solution composition. The radiolytic destruction of oxalate ion is rapid enough in solution of ^{244}Cm that this effect had to be considered in attempting to determine equilibrium solubilities. (M.C.G.)

15978 NFS: FIRST FUEL REPROCESSOR. Cramer, T. L. Nucleonics, 24: No. 12, 48-52(Dec. 1966).

The West Valley commercial fuel-reprocessing plant of Nuclear Fuel Services, Inc. (NFS) located south of Buffalo, New York, is discussed. The Purex solvent-extraction process is used at the plant. The plant, chemical-process cell, partition cycle, uranium extraction cycles, plutonium extraction cycle, organic solvent recovery, acid recovery, rework system, and waste handling are described. An appraisal by NFS of other processors and processes is given. (D.H.M.)

15979 IMPROVED METHOD FOR REMOVAL OF TRITIUM FROM HELIUM. Akhtar, Sayeed; Smith, Hilton A. (University of Tennessee, Knoxville). Rev. Sci. Instrum., 38: 432(Mar. 1967).

An improvement in a previously described method by S. Akhtar and H. Smith (Rev. Sci. Instr. 36, 1250(1965)) for the removal of tritium from ^{3}He is presented. (B.G.D.)

15980 INVESTIGATIONS ON THE CHLORINATION PROCESSING OF FUEL ELEMENTS. II. THE CHLORINATION OF URANIUM DIOXIDE–MOLYBDENUM SINTER TABLETS AND SEPARATION OF URANIUM CHLORIDES FROM MOLYBDENUM CHLORIDES AND FISSION PRODUCT CHLORIDES BY VACUUM SUBLIMATION. Parthey, Harry; Kanellakopulos, Basil (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 8: 863-5 (Sept. 1966). (In German).

Reactor-irradiated UO_2–Mo sinter tablets were treated with a Cl_2–CCl_4 mixture to form UCl_4, $MoCl_5$, and fission product chlorides. Iodine and rare gases were volatilized during the chlorination reaction and are not condensed, in contrast to the chlorides, after leaving the reaction chamber. The chlorides were separated by vacuum sublimation. Radiochemical, γ-spectrometric, and x-ray-fluorescence methods were used to determine the decontamination factors for some of the most important fission nuclides and the separation factor for the separation of molybdenum from uranium. (tr-auth)

15981 RADIOCHEMICAL SEPARATION BY MEANS OF THE RING-OVEN METHOD. I. THE SYSTEM $^{137}Cs-^{137m}Ba$. Klockow, D. (Univ., Freiburg i. B.). Talanta, 14: 317-21(Mar. 1967). (In German).

The application of the ring-oven method to radiochemical separations is exemplified by separation of the mother–daughter pair $^{137}Cs/^{137m}Ba$. The ^{137m}Ba was separated from ^{137}Cs in about 2 min on a filter circle impregnated with an insoluble ferrocyanide or heteropoly acid salt, and after re-establishment of radioactive equilibrium was "milked off" again. The yield of ^{137m}Ba obtained was 80 to 100% for the ferrocyanide-impregnated paper and 50 to 70% for a paper impregnated with a phosphomolybdate or tungstomolybdate. The decontamination factor ranged from 10^3 to 10^5. The half-life of the separated ^{137m}Ba was calculated to be 2.570 ± 0.006 min. (auth)

15982 RADIOCHEMICAL SEPARATION OF LEAD BY AMALGAM EXCHANGE. Qureshi, Iqbal H.; Nagi, Fazal I. (Atomic Energy Centre, Lahore). Talanta, 14: 323-7(Mar. 1967).

An amalgam exchange technique was used for the rapid radiochemical separation of lead. A number of variables that affect the exchange were studied and a lead yield of 88.5% was obtained. At room temperature the procedure required about 13 min, whereas at 40°C it was completed in about 9 min. Radioactive tracers of 16 different elements were used to check the selectivity of this procedure, which was applied for the separation of ^{212}Pb from thorium nitrate solution. (auth)

15983 ISOLATION OF THORIUM IN BIOLOGICAL SAMPLES. Toribara, T. Y.; Koval, L. (Univ. of Rochester, N. Y.). Talanta, 14: 403-7(Mar. 1967).

A scheme for the isolation of subpicogram to microgram amounts of thorium from bone and soft tissue samples is described. Thorium was collected by co-precipitation with iron(III) hydroxide and adsorbed by a cation-exchange resin column from a concentrated hydrochloric acid solution of the precipitate. A double precipitation was necessary for bone samples whereas a single precipitation sufficed for liver samples. The thorium was eluted from the column with an ammonium carbonate solution, which was then evaporated to dryness to effect the isolation. Good recoveries of thorium from bone samples were obtained. (auth)

15984 REMOVAL OF RADIOACTIVE CESIUM CONTAMINANTS FROM SIMPLE AQUEOUS SOLUTIONS. Davis, B. M.; Sebba, F. (Univ. of Witwatersrand, Johannesburg). J. Appl. Chem. (London), 17: 40-3(Feb. 1967).

Cesium ions can be removed from aqueous solutions by forming a precipitate of copper ferrocyanide that, having occluded the Cs ions, can be floated by means of an anionic collector. Collection was achieved with either α-sulfopalmitic acid or sodium dodecyl sulfate, depending on what interfering ions were initially present in the solution. Recoveries of 98 to 99% were obtained on batch scale experiments and 97.5 to 98.5% on continuous scale operation. Investigations of the flotation parameters of pH, gas-rate, concentrations of precipitating reagents and collector, as well as the interference effects of other ions, are discussed. Using data obtained in batch scale tests, continuous scale experiments were designed and operated. (auth)

15985 AMALGAM METHOD FOR SEPARATION OF SAMARIUM FROM CERIUM. Sayun, M. G.; Timofeeva, T. G. Zh. Prikl. Khim., 39: 1256-9(June 1966). (In Russian).

The separation of cerium from samarium by an amalgam method involving control of the anodic potential was investigated. Cerium was determined quantitatively by radiometric or spectrophotometric analyses. Depending upon the temperature, anodic current density, and other factors, the decomposition of samarium amalgam begins at –1.3 to –1.2 V, and that of cerium at –0.9 to –0.5 V. A mixed cerium–samarium amalgam was decomposed by controlling the anode potential; after the extraction of samarium from the amalgam, the anode potential was found to jump sharply upward to values necessary for the oxidation of cerium. This proved the feasibility of removing cerium from samarium by the controlled potential method. Experiments showed that two consecutive operations of separation produced a samarium concentrate of almost 100% purity. (ATD)

15986 STUDIES OF THE EXTRACTION OF METAL IONS USING RADIOACTIVE NUCLIDES. PART XII. THE EXTRACTION OF TETRAVALENT AND HEXAVALENT ACTINIDES IN THE SYSTEMS TBHP–TBPP (1:1)/HNO_3 AND TBPP/HNO_3. Mikulski, J.; Gavrilov, K. A. (Institut fuer Kernphysik, Krakow. Institut fuer Kernforschung, Dubna, USSR). Kernenergie, 9: 289-92(Sept. 1966). (In German).

The extraction U, Np, and Pu in the systems butyl hypophosphate (TBHP)–butyl pyrophosphate (TBPP) (1 : 1)/HNO_3 and TBPP/HNO_3 was investigated using ^{233}U, ^{235}U, ^{237}Np, and ^{239}Pu. The extraction of HNO_3 to the organic phase was measured and the solvation numbers for U were determined. (tr-auth)

15987 CONSECUTIVE ANION EXCHANGE SEPARATION OF RADIUM, THORIUM, PROTACTINIUM, AND URANIUM FROM AN IRON CARRIER. Komura, Kazuhisa; Sakanoue, Masanobu (Kanazawa Univ., Japan). Bunseki Kagaku, 16: 114-18(Feb. 1967). (In Japanese).

Separation of long-lived radionuclides, which belong to the uranium and actinium series, was investigated by using an anion exchanger resin Dowex 1-X 8. Radioactive tracers (^{237}U, ^{233}Pa, ^{234}Th, ^{224}Ra, and ^{59}Fe) were prepared by proper methods and used for examining the chemical behaviors of these elements on anion exchange resin. It was confirmed by a batch method that radium was not absorbed on the oxalate resin, while uranium, protactinium, thorium, and iron were strongly adsorbed on the resin from various concentrations of oxalic acid solution (0.02 to 0.5M). The separation of radium from these elements can be easily realized by passing oxalate solution through the column and washing with 0.5M oxalic acid solution. Stepwise separation of adsorbed elements was studied by various eluents. Thorium can be eluted by passing 8N–HCl solution through the column, converting the resin form from oxalate to chloride. Then, by adding hydrofluoric acid to the eluent, protactinium can be easily eluted. Separation of uranium from iron was difficult because of the similar behaviors of both elements on chloride form resin, but it was successfully accomplished by using a mixed medium of 6N HCl–1N $HClO_4$ as an eluent. Iron was adsorbed strongly on the column by this procedure. (auth)

15988 SEPARATION OF LANTHANIDES AND ACTINIDES ON ION EXCHANGERS BY HYDROXYETHYLENEDIAMINETRIACETIC ACID. II. STUDY OF THE INFLUENCE OF THE pH ON THE SEPARATION FACTOR AND THE COLUMN EFFICIENCY. Merciny, E.; Duyckaerts, G. (Univ., Liege). J. Chromatogr., 26: 471-80(Feb. 1967). (In French).

The effect of pH on the separation of the pairs Am–Cm and Eu–Gd on ion exchangers using hydroxyethylenediaminetriacetic acid (HEDTA) as the eluant was studied. Static and dynamic experiments showed that, in the region from pH 2.1 to about 2.65, the behavior of the four elements as a function of the pH accords exactly with expectations based on the pK of HEDTA and the formation of a complex $MY(H_3Y \equiv HEDTA)$. In contrast to this, in the pH region 2.65 to 2.9, some anomalies were observed for the four cations as regards the partition coefficients as well as the number of plates and the separation factors. (auth)

15989 FEED INJECTION FOR HEATED FLUIDIZED BEDS. Legler, B. M. (Phillips Petroleum Co., Idaho Falls, Idaho). Chem. Eng. Progr., 63: No. 2, 75-82(Feb. 1967).

Various types of nozzles for injecting waste solutions into heated fluidized beds were tested. Results indicated that a two-fluid pneumatic atomizing nozzle submerged in the bed performed best. (J.G.B.)

15990 PROCESSING OF PLUTONIUM BY ION EXCHANGE. VI. PLUTONIUM(IV) SORPTION KINETICS ON DOWEX 1x4 FROM NITRATE SOLUTIONS. James, D. B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 2: 379-89(Oct. 1966).

The kinetics of the sorption of plutonium(IV) on Dowex 1 × 4 from nitrate solutions are presented. Sorption rates from various nitric acid and mixed aluminum nitrate–nitric acid solvents were studied. The particle-diffusion-controlled reaction proceeded with an apparent average diffusion coefficient that decreased exponentially with increasing plutonium sorption. The results agreed reasonably well with a computer solution of Fick's law with the local intraparticle diffusion coefficient proportional to the local intraparticle fraction of unreacted exchange sites. The trace-sorption diffusion coefficient was strongly dependent on the composition of the aqueous phase, and was empirically shown to be roughly inversely proportional to the product of the trace-sorption distribution coefficient and the ratio of the hydronium ion-to-water concentrations. These kinetic results and previously reported equilibrium parameters may be coupled with the fundamental partial-differential equation, which describes the operation of a fixed-bed anion exchange column to allow computer optimization of plant-scale processing equipment. The effects of the variation of such parameters as volume and mass flow rate, temperature, plutonium feed concentration, and macro concentrations of aluminum nitrate in the feed are qualitatively discussed for one equipment design. (auth)

15991 SOME PROBLEMS IN THE SEPARATION, BY PRECIPITATION, OF TRACES OF ELEMENTS. I. SEPARATION OF MINUTE AMOUNTS OF URANIUM FROM IRON(III) AND FROM OTHER ROCK CONSTITUENTS WITH THE AID OF SODIUM CARBONATE. Upor, Endre; Nagy, Gyula. Acta Chim. Acad. Sci. Hung., 50: 5-21(1966).

Losses occurring in the adsorption of minute amounts of uranium by great amounts of precipitates, mainly of iron(III) hydroxide in sodium carbonate were investigated. At sodium-carbonate concentrations over 0.2 M the losses of uranium did not depend on the carbonate concentration. The pH value played an essential role. In case of iron(III) hydroxide, losses showed a minimum in the pH range 9.2 to 10.2, with maximum value at pH 12.7. Subsequently, dissolution rates increased, due to increase of OH^- concentration. Peak values occurring at various temperatures coincide if the real p_{OH} values serve as a basis. The adsorption of uranium was investigated also with other compounds of importance in rock analysis. Of these substances mainly aluminum hydroxide and tricalcium phosphate caused heavy uranium losses. Curves of adsorption plotted against pH values were not affected by the presence of high ionic strengths or that of hydrogen peroxide, either. In iron(III) hydroxide, losses of practically identical extent were experienced both in coprecipitation and subsequent adsorption of uranium. Tests indicated that the extractability of uranium is not altered by ageing the precipitate in a carbonate medium. However, ageing the hydroxide precipitate in a medium free of carbonate substantially deteriorated the extractability of uranium with carbonate. Under the optimum conditions, it was possible quantitatively to separate minute uranium amounts from iron(III) hydroxide as required by trace element analysis. On the basis of a great number of analyses, this could not be attained in the analysis of rock samples where losses ranged from 15 to 50%. (auth)

15992 LARGE-SCALE MANUFACTURING PROCESS FOR SEPARATING URANIUM, PLUTONIUM, AND FISSION PRODUCTS BY CHLORINATION. **Horvath, Arisztid Lajos.** British Patent 1,056,802. Feb. 1, 1967. Filed Apr. 15, 1965.

A process for the separation of U, Pu, and fission products by chlorination of finely divided U fuel consists of advancing the fuel through a multiple-hearth furnace heated to a temperature of 400 to 700°C, contacting the advancing U fuel in an air-free atmosphere with a recirculated gas mixture introduced countercurrent to the advancing U fuel, and containing Cl_2 and U chlorides higher than UCl_4. The U chlorides formed by the reaction are transported away from the reaction zone through a cyclone and filter, and the volatile U chlorides are condensed at a temperature of 100°C in a chamber. The noncondensed gases are recirculated into the multiple-hearth furnace through a heat exchanger where the gases are mixed with Cl_2. The residue containing the chlorides of Pu and the fission products is transferred continuously to a second furnace for recovery of Pu chlorides by volatilization at a temperature (750 to 850°C) below the volatilization temperature of the chlorides of the fission products. The condensation temperature of the Pu chloride in the second chamber is 200°C. (B.L.M.)

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Refer also to abstracts 16088–16090, 16096, 16302, and 16304.

15993 (BMwF-FB-K-66-42) MESSUNG DER TERRESTRISCHEN KOMPONENTE DER NATUERLICHEN γ UMGEBUNGSSTRAHLUNG IN DER BUNDESREPUBLIK DEUTSCHLAND. (Measurement of the Terrestrial Component of the Natural Gamma-Environmental Radiation in the Federal Republic of Germany). Geyh, M.; Lorch, S. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). Dec. 1966. 65p. (In German). Dep. mn.

Measurements for the determination of the terrestrial component of the natural environmental γ-radiation in the Federal Republic of Germany are reported. These measurements were carried out on roads and in buildings by means of scintillometers. The average dose rate on the roads was found to be 34.2, in buildings 70.0 (mr/year). These investigation results are in conformity with those of other countries. It is shown that the average dose rate measured on the roads differs in various regions of geological uniformity. Since the average staying time of man is the different environments of life is unknown, a computation of the average radiation load rate of the population has not been made. (tr-auth)

15994 (BNL–11080) GEOLOGIC DATING BY ELECTRON SPIN RESONANCE. Zeller, E. J.; Levy, P. W.; Mattern, P. L. (Brookhaven National Lab., Upton, N. Y.). Feb. 1967. Contract AT(30-2)-Gen-16. 13p. (CONF-670309–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, France.

A method of dating geologic samples is described which is based on a measurement, by electron spin resonance techniques, of the trapped charge induced in minerals by their radioactive impurities. The origin of the traps in minerals, charge creating ionization processes, and the factors controlling the retention of trapped charge are briefly reviewed. The principles of electron spin resonance (ESR) measurements are described with particular emphasis on the detection of ESR signals in minerals and the measurement of trapped charge. This method has been applied to the dating of apatite crystals from Durango, Mexico. These crystals exhibit two ESR absorption peaks which increase in intensity when the crystals are irradiated with gamma rays. The pre-irradiation ESR signals, and the change in these signals induced by known gamma-ray doses are used to determine the total dose acquired during geologic time. The dose imparted to these crystals annually was computed from their radioactive impurity content, determined by scintillation counting. The age computed from the geologic dose and the annual dose rate is 2 to 4×10^6 years. Cursory annealing measurements indicate that the apatite ESR signals are associated with traps that will retain charges in excess of 4×10^6 years. Although the apatite samples have not been independently dated, the stratigraphy of the Durango region puts an upper limit on their age as approximately 5×10^7 years. (auth)

15995 TRANSPORT AND DISTRIBUTION OF RADIOACTIVE EFFLUENTS IN COASTAL AND ESTUARINE WATERS OF THE UNITED KINGDOM. Templeton, W. L. (United Kingdom Atomic Energy Authority, Windscale, Eng.); Preston, A. pp 267-89 of STI-PUB–126.

The available data on the transport and distribution of radioactive effluents in coastal and estuarine waters of the United Kingdom are discussed. The major part is derived from surveys following the disposal of fission products from the fuel element reprocessing plant of the UKAEA at Windscale. Some data are presented on the disposal of corrosion products from a C.E.G.B. nuclear power station into the Blackwater Estuary. In the Irish Sea, data collected between 1959 and 1965 on the concentration of radionuclides in sea water, seabed material, shore silt, algae, invertebrates and fish are presented to describe the pattern of distribution up to 50 miles from the discharge point. Hydrographic data are discussed to support this. Seaweed surveys around the coastline of the United Kingdom compare the levels at Windscale with background fallout levels and indicate the limit of Windscale contamination to be at 75 to 100 miles. A comparison of ^{137}Cs concentration in fish, sampled from fresh waters in high and low rainfall areas, from the Irish Sea, and from other sea areas is presented. In the Blackwater Estuary, data on the concentration of ^{65}Zn in oysters are presented and the distribution in the estuary discussed. (auth)

15996 TRANSPORT OF RADIONUCLIDES IN A MODEL RIVER. Gloyna, E. F. (Univ. of Texas, Austin); Bhagat, S. K.; Yousef, Y.; Shih, C. pp 11-32 of STI-PUB–126.

A model river system was used to conduct a variety of experiments involving releases of ^{58}Co, ^{85}Sr, ^{137}Cs, ^{65}Zn, and ^{103}Ru. These investigations were to evaluate the measurements involved in the transport of these radionuclides in an aquatic environment. Primary emphasis was directed toward the accumulation of quantitative uptake data and the interpretation of transference of these radionuclides from a liquid phase to sediments, the movement of the radionuclides from suspended sediments to bed sediments, the resuspension of radionuclides from bed sediments, and the sorption of the radionuclides on plant and animal forms. The net transport of selected radionuclides has been studied under a variety of environmental conditions. A fully-instrumented flume and reservoir complex was used to simulate typical ecological environments. A model river as represented by the flume has been used to develop more fully a comprehensive transport equation, thereby defining the transport coefficients needed to satisfy any prediction model. This system has been used to evaluate the effect of various environmental conditions on the net transport of the radionuclides. The effects of ecological changes, such as changes in predominant species, die-away, etc., have been measured. Continuous measurements have been made on total light input, filtered or usable light, oxidation-reduction potential, pH, air and water temperatures, and dissolved oxygen. Additional measurements such as carbon dioxide, plant mass, and dispersion have provided useful information. (auth)

15997 BEHAVIOUR OF RADIOISOTOPES RELEASED TO A STREAM. Tritremmel, Ch.; Knollmayer, G.; Wanderer, E.; Heintschel, H. G.; Stipanits, P. (Reactor Centre, Seibersdorf, Austria). pp 89-105 of STI-PUB–126.

The behaviour of various radionuclides in surface water was studied by field experiments in the Leitha–Mühl Canal and by complementary experiments in the laboratory. The boundary and profile characteristics of the stream were ascertained and flow rate calculated. Suspensions were examined for size and mineral or organic content in relation to current velocities, and core samples were collected from the bed at selected regions of deposition. Experiments were carried out on dispersion and transport of wastes under varying outlet conditions and the diffusion constant was measured. In the laboratory, sedimentation and uptake experiments were conducted on mineral and organic suspensions in conjunction with nuclides such as ^{90}Sr, ^{131}I, ^{140}La, ^{24}Na and mixed fission products. Uptake was found to be dependent on mineral species and varied inversely with particle size. Elution experiments were also carried out on accumulated sediments. From these results it is possible to assess the radioactive content and frequency of batch discharges of effluents that may be released to a river without causing unacceptably high concentrations. (auth)

15998 REACTIONS OF RADIONUCLIDES FROM THE HANFORD REACTORS WITH COLUMBIA RIVER SEDIMENTS. Nelson, J. L. (Battelle Memorial Inst., Richland, Wash.); Perkins, R. W.; Nielsen, J. M.; Haushild, W. L. pp 139-61 of STI-PUB–126.

On disposal to the Columbia River, effluent water from the nuclear reactors at Hanford contains many different radionuclides. These radionuclides provide numerous tracers for studying river phenomena. Among the radionuclides are activation products produced by n, γ reactions on water salts and smaller amounts of fission products resulting from fission of the trace quantities of uranium in the water. Although most of these radionuclides have such short half-lives or low abundances that they are not useful in studying river processes, ^{51}Cr, ^{65}Zn, ^{46}Sc, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{95}Zr–^{95}Nb, ^{106}Ru, ^{124}Sb and ^{140}Ba are present in sufficient amounts to serve as useful tracers. As these radionuclides are diluted and move downstream with the Columbia River water, various processes operate to remove some of each of them from solution. Some become associated with inorganic and organic suspended sediments, which either settle to the river bottom or are carried to the Pacific Ocean. The depletion, sedimentation, scouring and inventory of eleven radionuclides have been studied for a 350-km reach of the Columbia River over a three-year period to show depletions of radionuclides of as much as 90% and total radionuclide inventories in the deposited sediments of about 30,000 Ci. Much of this inventory is in the McNary Dam reservoir, the first major depositional area below Hanford. A study of sediment scouring from this reservoir by the spring freshet using the $^{65}Zn/^{51}Cr$ ratio in suspended sediments as a measure of sediment age indi-

cates that about 30% of the annual deposit may be moved downstream. Studies of the mechanisms of retention and release of radionuclides from the sediments indicate that the attached radionuclides are held tightly. They are not readily replaced by contact with salt solutions; sizeable fractions can, however, be removed with oxidizing agents, reducing agents and acidic solutions. Although no change in oxidation state occurs on sorption of most of the radionuclides by the sediments, ^{51}Cr is reduced from the hexavalent to the trivalent state. These findings have provided an understanding of many important processes in the Columbia River and can be extrapolated to provide predictions of radionuclide behaviour in other river systems. (auth)

15999 WATER EXCHANGE AND DIFFUSION PROCESSES IN TVAEREN, A BALTIC BAY. Gyllander, Christina (AB Atomenergi, Studsvik, Sweden). pp 207-20 of STI-PUB-126.

Research was conducted on water circulation and transport within Tvaeren Bay to determine the capacity of the bay for low-level waste disposal from the research center at Studsvik. The topographical conditions were mapped and hydrographic observations were made both in the bay and in the surrounding coastal areas. By using data on density stratification in Tvaeren and in the free water masses east of the area, it has been found from eight years' investigation that convection processes resulted in 5 annual total water exchanges to bottom level. An analysis of flow velocity in different straits as well as at several depths showed that the surface water above the sills — in total 140 Mm^3 — is renewed once a week. The following diffusion processes have been studied: Efficiency of initial dilution obtained by discharge from a plain-ended pipe and with attachments such as a nozzle or multiple-outlet diffuser and subsequent diffusion in the naturally moving waters beyond the local turbulence in the area of discharge. Measurements of instantaneous concentration were performed with scintillation detectors to a distance of 1 km from the release point. At the Health and Safety Section at Studsvik, a method has been developed for studying water diffusion using thermoluminescence dosimeters (type $CaSO_4$:Mn). Within the zone of initial dilution, the mean concentration has been studied with dosimeters arranged in a lattice normal to the jet flow and so recording the accumulated dose at each point in the system. By this method a picture free from random fluctuations has been obtained of the mean concentration and distribution related to exposure of a few hours. (auth)

16000 COMPETITION OF Ca, H, AND Sr IONS IN ADSORPTION OF ACTIVE AND INACTIVE Sr IN SOIL. Schroeder, D.; Freiherr von dem Bussche, G. (Christian-Albrecht-Univ., Kiel, Ger.). Landwirt. Forsch., 15: 190-5(1962). (In German).

The relative uptake and exchange values of Ca and Sr in so-called Ca-type and Sr-type soils were examined in relation to changes in pH. Within a concentration range of 100 m equiv inactive Sr to 0.5 μCi radioactive carrier-free Sr per 100 g soil, adsorption of both macro and micro quantities follows the same general laws. When Sr is adsorbed by a Ca-type soil, its greater affinity for the exchange sites relative to Ca (due to its greater ionic dia and lower degree of hydration) is masked by a hysteresis effect; this effect inhibits the exchange of the ions already adsorbed; hence the weaker adsorption of Sr ions as compared with Ca ions, in Ca soils. Given a constant metal ion and a decreasing H ion concentration, adsorption of Sr increases over the entire pH scale. If the concentration of metal ions is low and increases with the pH, Sr adsorption increases only within the very acid pH range (up to about pH 5). The influence of pH between pH 5 and 8 is slight, while above pH 8, in the presence of a high concentration of alkaline earth ions, the adsorption of Sr again declines. (BBB)

16001 ANALYSIS OF GAMMA-RAY SPECTRA FROM SOILS AND PLANTS. II. EFFECT OF TREES ON THE DISTRIBUTION OF FALLOUT. Franklin, R. E.; Gersper, P. L.; Holowaychuk, N. (Ohio Agricultural Research and Development Center, Wooster. Ohio State Univ., Columbus). Contract AT(11-1)-414. Soil Sci. Soc. Amer., Proc., 31: 43-5(Jan.-Feb. 1967). (COO-414-2).

The distribution of fallout in soil from a forested area was studied. Surface soil samples (0 to 7.5 cm) collected at several distances from the stems of beech (Fagus grandifolia), sugar maple (Acer saccharum), tulip (Liriodendron tulipfera), scarlet oak (Quercus coccinea), hickory (Carya glabra), and white oak (Quercus alba) trees were analyzed by gamma-ray spectroscopy. The concentration of ^{137}Cs in the soil near the stem of a beech tree was about five times higher than at other positions under the canopy. This effect was about one-half as great for sugar maple and much less for the other species. The magnitude of this concentration is apparently related to the quantity of stemflow water, which may be appreciable with some species and negligible with others. Samples collected at four depth intervals (0 to 7.5, 7.5 to 15, 15 to 22.5 and 22.5 to 30 cm), in an area which included three of the trees, were also analyzed. Considerable leaching of ^{137}Cs occurred in soil adjacent to tree stems, apparently as a result of stemflow. (auth)

16002 URANIUM AND THORIUM ABUNDANCES IN CARBONACEOUS CHONDRITES. Morgan, J. W.; Lovering, J. F. (Australian National Univ., Canberra). Nature, 213: 873-5(Mar. 4, 1967).

Determinations of uranium and thorium in carbonaceous chondrites by neutron activation show that both uranium and thorium are inhomogeneously distributed within Type I and are generally homogeneously distributed within Type II carbonaceous chondrites. If Type I carbonaceous chondrites represent primitive solar material, then for the experimentally determined values of the ratio $^{232}Th/^{238}U$ either a continuous or sudden model of nucleosynthesis is plausible. The value of this ratio does, however, raise some problems, which are discussed. (auth)

16003 EXCESS ^{129}Xe AND TELLURIUM ABUNDANCES IN CHONDRITIC METEORITES. Kuroda, P. K.; Clark, R. S.; Ganapathy, R. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 72: 1407-10(Feb. 15, 1967).

The extinct radioisotope ^{129}I appears to have been produced during the solar nucleosynthesis process by neutron-induced reactions. The formation intervals of a number of meteorites, especially gas-rich carbonaceous chondrites, were calculated on the basis of the production of ^{129}I. A new term is introduced called the "$^{129}Te-^{129}Xe$ formation interval." (R.C.K.)

16004 COSMOGENIC TRITIUM PROBLEM IN IRON METEORITES. Fisher, David E. (Univ. of Miami, Fla.). J. Geophys. Res., 72: 1351-4(Feb. 15, 1967).

Pieces of the Sikhote Alin iron meteorite have been irradiated with reactor neutrons to induce the $^3He(n,p)^3H$ reaction. The diffusive behavior of this ^3H has been measured as a function of time and of temperature. The results show that the low cosmogenic ^3H content of iron meteorites is not due to ^3H loss during atmospheric descent, but to diffusion loss at ordinary temperatures during the terrestrial residence time of the meteorites. (auth)

16005 MECHANISMS FOR THE MOVEMENT OF Mn, Fe, B, Cu, Zn, Al, AND Sr FROM ONE SOIL TO THE SURFACE OF SOYBEAN ROOTS (GLYCINE MAX). Oliver, S.; Barber, S. A. (Purdue Univ., Lafayette, Ind.). Soil Sci. Soc. Amer., Proc., 30: 468-70(July-Aug. 1966).

The role of root interception, mass-flow, and diffusion in supplying ions to soybeans growing in a leached subsoil was investigated. Root interception was the main mechanism for the supply of Cu, Al, and Sr to the soybean roots. Massflow was the most important for B and diffusion was the most important for Mn, Fe, and Zn. The data represent results on one soil, a leached Sidell silt loam subsoil. The levels of Mn, Fe, B, Cu, Zn, Al, and Sr in it were such as to make it useful for this study on the mechanism of movement of these ions. The significance of the mechanisms for the supply of each ion is affected by plant grown, climatic conditions, and soil. The mechanisms reported as being the most significant for each ion in this study are in many instances likely to be the same ones that are most significant under conditions where these ions are present at relatively low levels in the soil. The data illustrate how the amounts moved by each mechanism can be calculated to indicate their relative importance for determining the availability of the nutrients to plants growing in soil. (BBB)

16006 ACCUMULATION OF RADIONUCLIDES IN WATER WORKS FILTER BED MATERIAL. Wood, R.; Burden, B. A. (Ministry of Technology, London). Nature, 213: 637-8(Feb. 11, 1967).

The presence of manganese in water supplies can lead to formation of deposits and possibly to blockage of mains. Some water works employ a special precipitation and sand filtration process to remove the manganese. The sand becomes coated with MnO_2. Manganese-54 has been present in rain water in significant concentrations since the Soviet nuclear test series of 1961. The MnO_2 on the filter bed material examined contained some aluminium, calcium, iron and magnesium. The ^{54}Mn content was 458 pCi/g. Since MnO_2 absorbs radionuclides derived from fallout in water, the filter bed material was examined for such nuclides. Results are given for ^{90}Sr, ^{90}Y, ^{91}Y, ^{95}Zr, $^{106}Ru/^{106}Rh$, Te, ^{125}Sb, ^{137}Cs, ^{144}Ce, ^{144}Pr, and ^{147}Pm. The radionuclides of highest activity were those of Ce, Pm and Ru, which would be expected to be coprecipitated with the Mn. The concentration of ^{137}Cs was low and that of ^{90}Sr intermediate. It is considered that the presence of these nuclides was due to sorption from the water. Total α- and β- determinations revealed that a major part of the radioactivity was still unaccounted for. In view of this a qualitative gamma spectrometric analysis was made, which confirmed the presence of natural radioactivity. Results are given for ^{40}K, ^{232}Th, ^{226}Ra, ^{224}Ra

and alpha decay products, ^{228}Th, U, ^{226}Ra and alpha decay products, ^{210}Pb, and ^{210}Po. These results are discussed. Considerable activity due to ^{239}Pu/^{240}Pu was detected; this was probably unfissioned material originating from atmospheric nuclear explosions. The principal radionuclides present in the water appeared to be those of U, Ra and Pu; thorium was virtually absent. The total β-activity in the coating material was 493 pCi/g, and the total α-activity 840 pCi/g. (UK)

16007 STUDY OF THE DEPOSITION OF RADIOACTIVE FALLOUT IN CERTAIN PLACES IN BULGARIA. Radicheva, M. A.; Mishev, I. T. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 5-10(1966). (In Russian).

A number of investigations into the present activity of vegetation, soil, and water samples taken from various places in Bulgaria are described. In general, an increase in altitude over the sea level, results in an increase in the quantity of the fallout which has reached the soil and the plants on it, and the higher places are more abundantly covered with radioactive fallout. It was established that the active component of fallout is rapidly reduced after nuclear tests are discontinued. (tr-auth)

16008 DATING AND AUTHENTICATING WORKS OF ART BY MEASUREMENT OF NATURAL ALPHA EMITTERS. Keisch, Bernard (Nuclear Science and Engineering Corp., Pittsburgh); Feller, R. L.; Levine, A. S.; Edwards, R. R. Science, 155: 1238-42(Mar. 10, 1967).

A method for distinguishing between modern and old samples of lead has been used to analyze certain works of art. The basis of the method is the detection of radioactive lead-210, which decays with a 22-year half life when it is unsupported by its long-lived precursor, radium-226. The latter is separated chemically from lead when lead and lead products are prepared from the ore. (auth)

16009 NEUTRON RANDOM COUNTING ERROR IN TERMS OF SOIL MOISTURE FOR NONLINEAR CALIBRATION CURVES. Bell, J. P.; Eeles, C. W. O. (Natural Environment Research Council, Wallingford, Eng.). Soil Sci., 103: 1-3(Jan. 1967).

The most important potential source of error in estimation of soil moisture by the neutron scattering method is that due to random counting. Equations are given which may be appropriate to the type of scaler presetting facility and to the type of calibration. These equations may be used to guarantee a minimum level of precision for a series of measurements providing that the preset count, or preferably time, is calculated for the highest value of soil moisture to be encountered. (F.S.)

16010 THE PARTICLE SPECTRUM OF AN AEROSOL CHARGED WITH Rn DAUGHTER PRODUCTS. Reiter, R.; Carnuth, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). Naturwissenschaften, 54: 40-1(Jan. 1967). (In German).

The particle spectrum and the activity distribution in a mine with a Rn content of the water of 20×10^{-8} μCi/cm^3 were determined. The results are graphed and show that the frequency distribution of the particles have essentially a very broad maximum d = 0.04 and 0.1 μm. The radioactivity also exhibits a maximum at the smaller diameters of the particles. A second maximum of the activity was found between d = 0.008 and 0.02 μm. It was determined that approximately 37% of the activity occurs at maximum 1 and 50% at maximum 2. (J.S.R.)

Meteorology

16011 (CEA-76) LE TRITIUM ATMOSPHERIQUE. MESURE ET APPLICATIONS. (Atmospheric Tritium. Measurement and Application). Frejaville, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb. 1967. 24p. (In French). Dep. mn.

The possible origins of atmospheric tritium are reviewed and discussed. A description is given of enrichment (electrolysis and thermal diffusion) and counting (gas counters and liquid scintillation counters) processes which can be used for determining atmospheric tritium concentrations. A series of examples illustrates the use of atmospheric tritium for resolving a certain number of hydrological and glaciological problems. (tr-auth)

16012 (NP-16552) RADIOACTIVITY SURVEY DATA IN JAPAN. Numbers 11 and 12. (National Inst. of Radiological Sciences, Chiba (Japan)). May-Aug. 1966. 14p. Dep. mn.

Data on gross β activity and radioactivity of iodine in rain and dry fallout from the third Chinese nuclear test are presented. (R.C.K.)

16013 (NP-16585) OPERATION CENIZA-ARENA: TECHNIQUES FOR THE MEASUREMENT OF DEPOSITION AND REDISTRIBUTION OF FALLOUT AROUND STRUCTURES. Clark, Donald E. Jr.; Sartor, James D. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1966. Contract N228-(62479)-69928. 82p.

The continuing eruptions of Volcan Irazu and the consequent deposition of volcanic debris on the city of San Jose, Costa Rica, were used to study the deposition and redistribution of fallout-like particles (ceniza-arena) around structures. The techniques for the measurement of the deposition and redistribution of fallout were proof-tested and evaluated during the series of field measurements. The results were limited by the lack of volcanic activity during the measurement periods; however, the measurements showed a possible relationship between wind speed and the mass of fallout deposited. (auth)

16014 (NYO-3615-1) PROJECT STRAP. Final Report. Sherwood, R. D. (Isotopes, Inc., Westwood, N. J.). Jan. 30, 1967. Contract AT(30-1)-3615. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Impaction probe samples collected in the lower stratosphere and upper troposphere during November 1965 and March to April 1966 on WRB-57 aircraft weather reconnaissance flights were examined. Electron microscopic measurements of particle diameter (d) suggested a trimodal size distribution: a high population at $0.2 < d < 4.0$ micron, corresponding to previously reported ammonium sulfate particles; a higher population at $0.02 < d < 0.2$ micron, corresponding to reported data on Aitken nuclei and insoluble particles found within larger ammonium sulfate particles; and a high population at $0.008 < d < 0.02$ micron, suspected to be related to structures in the evaporated carbon thin film used for sample collection. Particle number concentrations of 0.05 to 1.5 cm^{-3} for $d > 0.2$ micron were higher than values from 1962 to 1963 probe samples, and concentrations of 1 to 15 cm^{-3} for $0.02 < d < 0.2$ micron were similar to reported values for Aitken nuclei measured in 1961. Presence of ammonium sulfate and persulfate was found by electron diffraction, and of silicon and sulfur by electron microprobe analysis, in agreement with previous work. Beta-count rates indicated that most of the activity was in particles smaller than 1.5 micron diameter. The beta activity for the impaction probes was under 15 percent of the values reported for filter paper samples exposed simultaneously on the same flight. Results of a simple wash procedure show from 2 to 75 percent activity loss via solubility and possible wash off. Particle morphologies resembled those of laboratory generated aerosols of several substances and it is suggested that possible chemical and phase changes occurred after collection. Recommendations to improve sampling and analysis are given. (auth)

16015 (USNRDL-TR-1105) COMPARISON OF THE FALLOUT MASS-SIZE DISTRIBUTIONS CALCULATED BY LOGNORMAL AND POWER-LAW MODELS. Freiling, E. C. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 14, 1965. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Fallout mass-size distributions presently used at USNRDL are compared with new distributions suggested by recent investigations. Available data are unable to define the distribution parameters well enough to distinguish between lognormal and power-law distribution models. (auth)

16016 HEAVY HYDROGEN AND LIGHT HELIUM. Bevington, J. G. (Univ. of Lancaster, Eng.). Educ. Chem., 3: 196-201 (July 1966).

Various aspects of H and He isotopes are discussed: their atomic structure, properties, production, use in labeling experiments, isotope effects in reactions, and use of ^{3}He in neutron activation analysis. The energies associated with nuclear changes are considered. Since tritium is formed in the upper atmosphere as a result of cosmic radiation, rainwater contains some molecules in which tritium atoms replace protium atoms. If it is assumed that the concentration of tritium in atmospheric water has not changed significantly over a period of years, it is possible to date such samples, i.e. to say when the water fell as rain. The experimental measurements involved in tritium dating are discussed, as are the 2 most significant production processes for tritium represented by the reactions ^{6}Li(n,α)^{3}H and ^{3}He(n,p)^{3}H. The production of tritium by the 2nd reaction is not of great practical importance because ^{3}He is rare. Preparative methods adapted for the syntheses of compounds labeled with tritium are referred to. Isotopes of an element are not identical in their chemical reactivity and the reactivity of a molecule containing deuterium may not be exactly the same as that of the corresponding molecule containing protium. In many cases, there are substantial differences between the rates of reactions involving the isotopes of H; in favorable cases, isotope effects on reaction rates can be detected without difficulty for carbon, nitrogen, and oxygen; for heavier elements, isotope effects must exist although they are very small. Effects in biological systems resulting from replacement of H_2O by D_2O, which arise from differences be-

tween the chemical reactivities and the characteristics of the O–D and O–H valency bonds, are also considered. (BBB)

16017 RELATIONSHIP BETWEEN STRATOSPHERIC CIRCULATION PATTERNS AND RADIOACTIVE DEBRIS IN EARLY 1963. Telegadas, Kosta (Air Resources Lab., Washington, D. C.). J. Appl. Meteorol., 6: 134-41(Feb. 1967).

The large scale atmospheric nuclear testing in 1961 and 1962 afforded the opportunity of observing changes in the distribution of radioactivity and its relationship to stratospheric circulation patterns. Aircraft observations in early 1963 from 15 to 21 km over the Northern Hemisphere and balloon observations to 30 km at 31N together with 50-mb constant pressure charts suggest that most of the debris injected into the polar stratosphere during November–December 1962 was confined to a relatively small volume north of 70N. This debris did not appreciably affect the zone south of 70N until February 1963 when the circumpolar vortex split into two cyclonic cells and moved southward, one cell over Europe, the other over Canada and the United States. This contaminant was then observed as far south as 25N. An anticyclone which moved over Alaska during February 1963 had different radioactivity characteristics than did the polar vortex. These well-defined large-scale eddies maintained their identity until May 1963 when the stratospheric distribution of radioactivity became more homogeneous. (auth)

16018 THE INFLUENCE OF THE DIURNAL CHANGES OF THE TURBULENT DIFFUSION COEFFICIENT ON Rn, THORON, ACTINON, AND THE DECAY PRODUCTS CONCENTRATIONS IN THE ATMOSPHERE. Bakulin, V. N. Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 3: 181-8(Feb. 1967). (In Russian).

An exact solution of the nonstationary equation of spreading in the atmosphere of ^{222}Rn, ^{220}Rn and its daughter products is obtained in an integral form. With the help of a computer this equation can be used to calculate the diurnal variation of the air radioactivity at any altitude. The exhalation of radon is a given function of time and the coefficient of turbulent diffusion is also a function of time which is constant with height. The results of such calculations are in a good agreement with experiments. A method is proposed for determination of the range of diurnal variations of turbulent diffusion coefficient if the changes of the air radioactivity are known. (tr-auth)

16019 A PHYSICAL STUDY OF SOLID PRECIPITATION FROM CONVECTIVE CLOUDS OVER THE SEA. PART I. DEUTERIUM CONTENT OF SNOW CRYSTALS WITH RESPECT TO CRYSTAL SHAPES AND THEIR RELATION TO ORIGINS OF THE WATER VAPOR OF SNOWFALL. Isono, K.; Komabayasi, M.; Takahashi, T. (Nagoya Univ., Japan). J. Meteorol. Soc. Jap., 44: 178-84(June 1966).

Deuterium content was determined in snow crystals and graupel pellets which fell on the coast of Japan facing the Japan Sea. The D/H ratios of snow were large (mean value 150 ± 2 ppM) when the snow flakes consisted of crystals having the same type of crystal habit. The D/H ratios were smaller (mean value 146 ± 3 ppM) when the precipitation consisted of graupel pellets, crystals, or a mixture of 2 different types of snow crystals. It is likely that this difference was due to the difference in the vertical development of the precipitating clouds. Temperatures of the sea surface from which the water for the snow fall had evaporated were estimated from the D/H ratio of snow samples. Since the horizontal water temperature gradient in the Japan Sea is very steep, the geographic location of this water vapor source could be determined. (BBB)

16020 CORRELATION OF THE CONCENTRATION OF RADIOACTIVE NATURAL AND FALLOUT AEROSOLS IN THE LOWER ATMOSPHERE. Shem'i-zade, A. E. At. Energ. (USSR), 22: 58-9(Jan. 1967). (In Russian).

On the basis of the analysis of aerosols collected on filters at an airflow rate of 8 l/min. cm^2, it was found that there is a definite correlation between the concentration of high-intensity, nuclear fission product fallout and radon decay products in the lower layers of the atmosphere. The samples were collected at a height of 1.5 m above the ground. The β decay of the collected aerosols was determined radiometrically. Comparison of the daily data obtained during the period from February to April, 1962, indicated that there is correlation factor of 0.780 between the concentrations of the natural and artificial β-active aerosols; turbulence near the surface or dryness of the soil may affect the data. No constant correlation could be established for samples collected later: the factor was found to be 0.184 for samples collected during June to August 1963 and 0.171 for the February, 1964 material. This may be due to the general reduction of the fission product concentration in the atmosphere, or to changes in the dispersivity of the aerosols. (TTT)

16021 ORIGIN AND DISSEMINATION OF RADIOACTIVE FALLOUT. Schumann, G. (Univ., Heidelberg). Naturwissenschaften, 54: 6-15(Jan. 1967). (In German).

A bibliographic review is given of recent studies on the origin and dissemination of radioactive fallout. The topics discussed are dating of the fallout, the origin of the fallout, fractionation of the original product, induced activities, fallout from satellite experiments, higher transuranic elements and indicator substances, particle groups and their measurement, transport over the earth, and dissemination in precipitation. (74 references). (J.S.R.)

16022 GIGENICHESKIE VOPROSY OKHRANY ATMOSFERNOGO VOZDUKHA OT RADIOAKTIVNYKH ZAGRYAZNENII. (Health Problems and Protection Against Radioactive Contamination of the Atmosphere Air). Novikov, Yu. V. Moscow, Izdatel'stvo Meditsina, 1966. 182p.

A brief review is given of the sources of natural and artificial radioactive air contamination and pollution and the methods for determining atmospheric radioactivity. The problems of atmospheric contamination by fallout from nuclear tests and from the peaceful uses of radioactive materials are analyzed and various means of health protection against radioactive atmospheric contamination are discussed. An extensive bibliography is included. (R.V.J.)

Mineralogy

16023 GENERAL CONSIDERATIONS ON THE DISTRIBUTION OF URANIUM IN GRANITOID ROCKS. Coppens, Rene; Jurain, Georges (Univ., Nancy, France). Geol. Rundsch., 55: 427-36 (1966). (In French).

The total U, fixed U, Fe, SiO_2, Na_2O, K_2O, and CaO contents for 248 rock samples were determined, and correlations between contents of U and the other elements sought. By use of specific examples, it was shown that it is possible to find, in a given granite, relations between U and the other elements, but that these relations cannot be generalized. They depend more on petrographical and mineralogical properties of the rocks than on the chemical composition. With the essential minerals some apparent relations were detected but they were valid only for a given rock. The nature of a granite depends, mainly, on its formation and consequently on the original material from which it derived. It is concluded that the presently available data on radioactivity of granites cannot be generalized. (BBB)

16024 GEOCHEMICAL PROFILE OF URANIUM, SELENIUM, AND RHENIUM IN THE ZECHSTEIN OF THE LESZCZYNA TROUGH. Kanasiewicz, Jerzy (Instytut Geologiczyn, Warsaw). Kwart. Geol., 10: 309-14(1966). (In Polish).

The U, Se, and Re contents of the Zechstein deposits occurring in the Leszczyna trough were determined. The highest concentrations of these elements occur in the Lower Zechstein beds, where their mean contents are as follows: U, 11.3 ppM; Se, 2.31 ppM; and Re 1.06 ppM. The results of the assays are presented in a chart showing the variation of the level of each element with the geologic strata. In the underlying, posteruptive series of the Rotliegendes the U content does not exceed 1.5 ppM. In the limestones of Middle Zechstein age the mean U content amounts to 2.2 ppM. In these beds Se and Re are found in small quantities, below the sensitivity of the analytical methods applied during the study. No interrelations were detected between the levels of the elements examined. It was found that neritic facies, associated with a shallow marine basin with an oscillating bottom, rich in clayey and organic materials, was the most favorable geochemical environment for concentration of U and the other elements considered. (BBB)

16025 SIGNIFICANCE AND USE OF OPTICAL PHENOMENA IN URANIFEROUS CAUSTOBIOLITHS. Jedwab, Jacques (Univ. Libre, Brussels). pp 119-32 of Coal Science. Advances in Chemistry Series No. 55, Washington, D. C., American Chemical Society, 1966.

Microscopic and autoradiographic methods were used to study uraniferous organic materials. It was shown that optical anomalies are widespread in uraniferous carbonaceous materials from different geological ages, such as bituminous and anthracitic coals, coalified logs, bituminous shales, and asphaltic sandstones. These optical anomalies, expressed by high reflectivity and anisotropic halos, are very stable, once acquired, in the course of history of the sediment. Under reflected light radioactive minerals (zircon, uraninite, coffinite) enclosed in organic material were surrounded by a clear halo of more than 20-μ width. This halo corresponded to a zone of increased anisotropy, reflectivity, and hardness. The outline of the halos was determined by those of the radioactive inclusions; therefore, they were circular, banded, or irregular and asymmetrical. At this time it is not yet known if the intensity of optical anomalies is cumulative and proportional to the radiation doses received. Nevertheless, it is possible to evaluate the time of introduction of U, the epigenetic vs syngenetic type of origin of

U, and plastic and fault-like movements of the organic materials. (BBB)

16026 GEOLOGY AND URANIUM DEPOSITS OF THE PUMPKIN BUTTES AREA OF THE POWDER RIVER BASIN, WYOMING. Sharp, W. N.; McKay, E. J.; McKeown, F. A.; White, A. M. U. S. Geol. Surv. Bull., 1107-H: 541-638(1964).

Studies were directed toward identification of the geologic, chemical, and physical factors that controlled U deposition and toward determination of criteria for discovery of additional U deposits. Uranium deposits are closely related to the hematite-red coloring in the sandstone lenses in this area. Tyuyamunite, metatyuyamunite, carnotite, uranophane, and trace amounts of hewettite and pascoite are disseminated in yellowish-brown or grayish-yellow sandstone where it is in contact with red sandstone. Where the contact is very irregular and forms irregular podlike extensions of red into drab sandstone, concentrations of secondary U minerals may occur in the drab sandstone. Uraninite, pyrite, and paramontroseite associated with coalified wood occur as cement in pods in red sandstone near irregular contacts with drab sandstone. Uranophane is chiefly in the cores and is peripheral to manganese oxide concretions. Pyrolusite, manganite, and psilomelane are the chief Mn minerals. All U minerals are contemporaneous with calcite. The concentrations of U, V, Fe, and Mn minerals and calcite seem to have formed by the redistribution and concentration of original components of the sandstone lenses. Oxidized U and V minerals and manganese oxides formed in a general alkaline oxidizing environment. Unoxidized minerals, paramontroseite and uraninite with associated pyrite, formed in small local zones of a low redox potential, predominantly around coalified wood. (BBB)

16027 DISTRIBUTION OF ELEMENTS IN SEDIMENTARY ROCKS OF THE COLORADO PLATEAU: A PRELIMINARY REPORT. Newman, William L. U. S. Geol. Surv. Bull., 1107-F: 337-45(1962).

Sandstone type U deposits of the Colorado Plateau were studied. In spite of the wide areal distribution of U deposits, and even though deposits are known in host rocks of greatly different ages, most U ore has been mined from sandstone strata of Late Triassic and Late Jurassic ages. To provide information on the geochemical environment of the U deposits, a regional study of the distribution of elements in the rocks and ores of the Colorado Plateau was made. Distribution, volume, and lithologies of these sedimentary rocks together with the distribution of elements in them provided background data to understanding the genesis of U deposits. The gross chemical compositions of sandstone, mudstone, and limestone from many formations were determined chiefly by spectrographic analysis, and selected samples analyzed by chemical methods. The distribution of Cu and V in unmineralized sandstone offers a good possibility of defining large areas of potential U-bearing rock on the basis of variations in concentration of these two elements. The distribution of Cr, Ti, Zr, B, Yb, V, Cu, and U in unmineralized sandstones of the Shinarump and Moss Back members showed 2 areas that contain abnormally high concentrations of these elements and may reflect possible source areas for detritus in these members. Variations in chemical composition of sandstone from many formations with regard to the occurrence of U deposits showed that sandstones containing about half a percent of K or less are more favorable than sandstones containing more K. (BBB)

Oceanography

Refer also to abstracts 16090 and 16309.

16028 (ORNL-3721(Suppl.2A)) RADIOACTIVE MATERIALS IN BOTTOM SEDIMENT OF CLINCH RIVER. PART A. INVESTIGATIONS OF RADIONUCLIDES IN UPPER PORTION OF SEDIMENT. Carrigan, P. H. Jr.; Pickering, R. J.; Tamura, T.; Forbes, R. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 94p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Supplement to Status Report No. 5 on Clinch River Study.

Progress is reported on studies of the deposition of radionuclides in the upper portion of the bottom sediments of the Clinch and Tennessee Rivers. Information is presented on the following topics: the fate of radioactive materials currently being discharged into the Clinch River; dispersion and mechanisms of dispersion of radionuclides released to the river; evaluation of the hazards of current disposal practices in the river; and an evaluation of the river's usefulness for waste disposal. (F.S.)

16029 (ORNL-3721(Suppl.2B)) RADIOACTIVE MATERIALS IN BOTTOM SEDIMENT OF CLINCH RIVER. PART B. INVENTORY AND VERTICAL DISTRIBUTION OF RADIONUCLIDES IN UNDISTURBED CORES. Carrigan, P. H. Jr; Pickering, R. J. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 92p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Supplement to Status Report No. 5 on Clinch River Study.

Inventory, retention, and distribution of radionuclides in bottom sediment of the Clinch River, and factors influencing association of radionuclides with this sediment have been experimentally investigated. Core samples of bottom sediment were collected by means of a Swedish Foil Sampler from a 21-mile reach of the Clinch River. Four to thirteen cores were obtained from each section, the number depending on the transverse distribution of the bottom sediment. Physicochemical analyses, included gross gamma counting, gamma spectrometry, radiochemical extractions and beta counting, particle-size analyses, mineralogical analyses and determinations of cation exchange capacities and leachable cation content. The total quantities of the principal radionuclides contained in bottom sediment at the time of sampling in July 1962 were: 150 curies of ^{137}Cs, 18 curies of ^{60}Co, 16 curies of ^{106}Ru, 2.9 curies of ^{90}Sr, and at least 10 curies of rare earths. Through comparison of the inventory to the total release of each radionuclide to the Clinch River for the period of record, 1943 to 62, (adjusting for radioactive decay) the percentage of retention is computed to be: 21 percent for ^{137}Cs, 9 percent for ^{60}Co, 0.4 percent for ^{106}Ru, and 0.2 percent for ^{90}Sr. Retention of rare earths may approach, and possibly exceed, 25 percent. Ninety-five percent of the total amount of radionuclides in the sediment is in one section of channel. The longitudinal distribution in the river, based on mean sectional concentrations, is similar throughout the study reach for all radionuclides. Highest radionuclide concentrations occur at, or near, the mouth of White Oak Creek, where the smallest sectional volume of radioactive sediment in the reach is found. Similar patterns in the distribution of gamma radioactivity with depth in the sediment, largely controlled by the distribution of ^{137}Cs, were observed in cores collected throughout the 21-mile reach. This persistent pattern indicates that more or less regular sediment deposition, as well as net accumulation of sediment, has taken place at the sites sampled. However, there were parts of each sampling section in which either no sediment deposits were found or the sediment present was not radioactive. The vertical distribution of ^{137}Cs in the sediment reflects annual variations in the release of this radionuclide to the Clinch River. Strong similarities in vertical distribution patterns of ^{137}Cs and ^{60}Co in the sediment suggest that incorporation of these radionuclides in Clinch River bottom sediment was due to deposition of radioactive suspended sediment originating almost exclusively from White Oak Creek. The radioactive sediment may be classed as a clayey silt, with surprisingly little vertical variation in mineralogical composition and in cation exchange capacity. The sand- and silt-size fractions of the sediment are composed largely of quartz grains. The clay-size fraction is made up of varying mixtures of mica, clay minerals, and quartz. (auth)

16030 OBSERVATIONS AND THEORY OF EDDY MOVEMENT AND DIFFUSION OF AN INTRODUCED TRACER MATERIAL IN THE SURFACE LAYERS OF THE SEA. Pritchard, D. W.; Okubo, A.; Carter, H. H. (Johns Hopkins, Univ., Baltimore). pp 397-424 of STI-PUB-126.

The fate of radioactive materials introduced into the sea depends upon physical, chemical and biological processes. Studies of the physical processes of movement and diffusion of these materials were made. Experimental releases of a tracer fluorescent dye are described and pertinent features of the observed movement and diffusion summarized. The tracer was initially introduced as a vertical column of small horizontal extent. As the tagged volume is moved by the mean current and spread by eddy motion, its shape becomes elongated. During the first few hours the elongation sometimes became quite marked, and also showed a characteristic curvature. These early features are related to an Ekman-type wind drift superimposed on the mean motion. During later stages of dispersion the elongation of the patch results from features of the eddy motion other than wind-induced currents. The direction of elongation was sometimes observed to be at a significant angle to the direction of the mean current. For any given experiment, the observed decrease of peak concentration with time showed a functional dependence which was different during small times than during large times after release. Further, the experiments fell into two groups. In one group the peak concentration decreased as T^{-1} (where T = time after release) for a short period (4 to 8 h), and as T^{-2} thereafter. In the second group, the peak concentration decreased as $T^{-1.5}$ during the early period, and as $T^{-2.5}$ for large times. The characteristic elongation of the diffusing dye patch is not explained by existing published theory. A new theoretical solution is presented, which satisfactorily describes the decrease in peak concentration with time and the horizontal elongation of the dye patch. This theory includes both horizontal and vertical shear

in the mean velocity field, as well as anisotropy in the horizontal and vertical mixing processes. A second theoretical development is presented, which explains the orientation of the elongation of the diffusing patch with respect to the direction of the mean flow in terms of the horizontal divergence, shear, and vorticity of the mean velocity field. (auth)

16031 SMALL-SCALE HORIZONTAL DIFFUSION NEAR THE COAST. Ito, N.; Fukuda, M.; Tanigawa, Y. (Japan Atomic Energy Research Inst., Tokyo). pp 471-82 of STI-PUB-126.

Several small-scale dye release experiments were carried out by Japan Atomic Research Institute in the coastal water, both 500 to 2000 m offshore and on the shoreline, to estimate the dilution effect of radioactive effluents which would be released in the near future. In both experiments rhodamine B dye was used as the tracer and was released instantaneously at a single point. In the offshore experiments, dye patches were observed both by aerophotography from a helicopter and by the colorimeter on a survey boat; in the onshore experiments, they were observed by the use of a transit theodolite at the top of a tower constructed on the beach. The results of the experiments were analyzed on the assumption that the areal concentration of released material was always of an isotropic Gaussian distribution with its peak at the center of the dye patch, and with the introduction of the standard deviation of the velocity of fluctuating motion which would cause the oceanic diffusion. Diffusion formulas were developed for the small-scale horizontal diffusions, both offshore and onshore, with the relationship between the colored area of a dye patch and its distance from the release point, or time after release. These formulas were found to be successful for the systematic analysis of the results of dye release experiments under various conditions, such as the amount released, kind of dye, sensitivity of the photographs, and surface condition of the sea. (auth)

Seismology

16032 (UCID-5102) GROUND SHOCK MEASUREMENTS FOR PROJECT PRE-SCHOONER II. Wall, John F. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 1, 1966. Contract W-7405-eng-48. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Ground motion data to facilitate more accurate ground motion predictions for the proposed Schooner experiment and to evaluate the seismic effects of thick alluvium in the Snake River Valley were collected. It was found that all peak particle velocities were higher than anticipated, and regression analysis curves drawn to fit data have surprisingly steep slopes. From the small amount of data points, it is concluded that there was high detonation coupling and rapid attenuation of peak particle velocity. The thick alluvium in the Snake River Valley at Bruneau and Twin Falls amplifies peak velocities by factors of 6 and 3, respectively. Yield influences peak particle velocity to a power between 0.67 and 1.0. Expected velocity versus range relationships for Schooner are shown. (F.S.)

16033 MULTIDIMENSIONAL MAXIMUM-LIKELIHOOD PROCESSING OF A LARGE-APERTURE SEISMIC ARRAY. Capon, J.; Greenfield, R. J.; Kolker, R. J. (Massachusetts Inst. of Tech., Lexington). Proc. IEEE (Inst. Elec. Electron Eng.), 55: 192-211(Feb. 1967).

The experimental Large Aperture Seismic Array (LASA) represents an attempt to improve the capability to monitor underground nuclear weapons tests and small earthquakes by making a large extrapolation in the existing art of building arrays of spaced and interconnected seismic transducers. The LASA is roughly equivalent to 21 subarrays, each consisting of 25 sensors, spread over an aperture of 200 km. The present work considers the problem of designing a linear filter which combines the outputs of the 25 sensors in a subarray so as to suppress the noise without distorting the signal, or event. This filter provides a minimum-variance unbiased estimate of the signal which is the same as the maximum-likelihood estimate of the signal if the noise is a multidimensional Gaussian process. An extensive discussion of the theory of multidimensional maximum-likelihood processing is given. A computer program implementation of the maximum-likelihood filter is presented which employs the cross-correlation matrix of noise measured just prior to the arrival of the event. This time-domain synthesis procedure requires relatively large amounts of computer time to synthesize the filter, and is quite sensitive to the assumption of noise stationarity. The asymptotic theory of maximum-likelihood filtering is also given. An asymptotically optimum frequency-domain synthesis technique is given for two-sided multidimensional filters. This procedure is well suited to machine computation and has the advantage with respect to the time-domain procedure of requiring about 10 times less computation time. A description of a computer program implementation of the frequency-domain synthesis method is given which employs the spectral matrix of the noise estimated just before the arrival of the event. The experimental results obtained by processing several events recorded at the LASA are presented, as well as a comparison of the performance of the frequency-domain method relative to the time-domain synthesis technique. It is found that the signal-to-noise improvement given by the frequency-domain procedure is within 2 dB of the gain obtained with the time-domain procedure, and that the frequency-domain method is relatively insensitive to the assumption of noise stationarity. (auth)

16034 TIMES OF PROPAGATION OF P WAVES FROM EPICENTRAL DISTANCES OF 30 TO 90 DEGREES IN THE REGION OF THE SOUTHWEST PACIFIC. Dubois, J. (ORSTOM, Noumea, New Caledonia). Ann. Geophys., 22: 642-5(Oct.-Dec. 1966). (In French).

A comparison was made of the time of propagation of P waves for the southwest Pacific Ocean area, North America, Asia, and Europe for the thermonuclear explosion in the Aleutian Islands on October 29, 1965. Seismic data from many stations were analyzed, particularly that for Luganville, Koumac, and Noumea, situated at ~70° epicentral distance. A table lists the azimuths and residual times for many stations. An analysis of these data shows that the correction to the Jeffreys–Bullen tables at about 70° changes from –5 sec under continents to –1.5 sec under the Pacific Ocean. The 3.5 sec difference between continents and the Pacific Ocean is compared with Tryggvason's observations in Iceland and Scandinavia. Thus data for the stations in Reykajavik, Iceland and Kiruna, Sweden show a residual time difference of +2.7 sec for a 60 to 80° epicentral distance, and a P wave velocity in the upper mantle under the 2 sites of 7.4 and 8.36 Km/sec. A similar anomaly was noted in the upper mantle along the seismic arc of the New Hebrides (7.4 Km/sec). (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 16007 and 16032.

16035 (NESCO-S-359) WATER WAVES GENERATED BY SHALLOW WATER EXPLOSIONS. Final Report. Whalin, R. W.; Divoky, D. J. (National Engineering Science Co., Pasadena, Calif.). Sept. 1966. Contract NBY-66206. 64p. (CR-67,018).

Results of a study of the applicability of linear theory to the generation of explosion waves in shallow water are reported. The mathematical model developed for deep water wave generation is applied in the shallow water case using several different initial water craters exposing the bottom; the initial disturbance may be either stationary or time-dependent with an initial velocity field. The resulting wave trains are shown in a series of figures as a function of time at a fixed location. Available data for waves generated by shallow water explosions are analyzed in an attempt to establish the limits of validity of the linear theory. It is concluded that at this time the available data are inadequate for this purpose. The possibility of simulating shallow water explosion waves in a wave tank by use of a plunger is discussed in light of the previous analytical and empirical considerations. (auth)

16036 (UCRL-50177) SOME CHARACTERISTICS OF THE HARDHAT CHIMNEY AND SURROUNDING WALL ROCK. Boardman, Charles R. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 1966. Contract W-7405-eng-48. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Hardhat event was a 4.9 ± 1.5 kt nuclear explosion at a depth of 286.2 meters in granodiorite. Data from three underground drill holes have been analyzed in an effort to further define chimney characteristics. The chimney radius was determined to be 20.3 m near shot point level and 17.7 m near the apical void. The earlier determined cavity radius of 19.2 m was confirmed. Total chimney volume is calculated to be 113,860 m^3, consisting of 30,800 m^3 of void space and 222 million kilograms of rock. Of the total chimney volume, 27% is void space. In the rubble column itself, exclusive of the apical void, 22% is void space. The nature of the radioactive melt and its distribution in the puddle suggest that the cavity did not collapse until H + 11 hours when an audible rumble was heard. The zone of highly crushed rock outside the chimney is calculated to have a void volume of about 2500 m^3, roughly 8% of the void volume inside the chimney. (auth)

16037 INDUSTRIAL AND SCIENTIFIC APPLICATIONS FOR NUCLEAR EXPLOSIVES. Gerber, Carl R. J. Brit. Nucl. Energy Soc., 6: 24-47(Jan. 1967).

The effects of nuclear explosions are reviewed, and the course of cavity chimney formation in an underground explosion is described; formulae are given for cavity radius and chimney height estimation. Studies of large-scale excavation are continuing and the possibility of a sea-level canal between the Atlantic and Pacific Oceans is currently under examination. Other applications discussed include the stimulation of oil and natural gas reservoirs, the liberation of petroleum from oil shale, the storage of crude oil and natural gas, applications in the mining industry, and the development and management of water resources. Safety is discussed from the points of view of seismic waves and release of radioactivity. Projected charges of $350,000 to $600,000 for 10 kt to 2 Mt for thermonuclear explosives are published for use by industry in feasibility studies. The scientific research application is considered for the strong shock waves, hot plasmas, x rays, gamma rays, neutrons and electrons produced in nuclear explosions. The uses of the effects in neutron physics, heavy element, and seismic studies are discussed. (UK)

16038 SIMULTANEOUS RECORDING OF RESONANCES OF THE EARTH-IONOSPHERE CAVITY AT TWO STATIONS 12,000 Km DISTANT. Etcheto, Jacquelin; Gendrin, Roger; Karczewski, Jean-Francois. Ann. Geophys., 22: 646-8(Oct.-Dec. 1966). (In French).

Ionospheric perturbations affecting the frequencies of the resonance of the earth-ionosphere cavity have been detected after high altitude thermonuclear explosions. These disturbances may be distinguished from diurnal variations in the frequencies of resonance, which may be explained by an inhomogeneous model of the ionosphere whose characteristics depend on geographic coordinates, local time, and direction of propagation. Differences of attenuation between NS and EW propagations registered at 2 stations 12,000 Km distant, namely, Chambon-la-Foret (48°01′ N, 2°26′ E) and Port-aux-Francais (49°10′ N, 70°10′ E), were examined. The diurnal variation of the Schumann resonances (recorded simultaneously on 2 orthogonal components at the 2 stations) was shown to be explained entirely by geometrical factors relating the position of the sources and of the observation points; no local ionospheric effect is involved. However, the significant difference which appeared between the EW and NS propagation characteristics must be taken into account in any theory to explain the diurnal frequency variation of these resonances. (BBB)

16039 NEUTRON ACTIVATION PRODUCTS FROM PROJECT SEDAN IN PLANTS AND SOILS. Romney, E. M.; Rhoads, W. A. (Univ. of California, Los Angeles). Soil Sci. Soc. Amer., Proc., 30: 770-3(Nov.-Dec. 1966). (UCLA-12-589).

Neutron activation products of tungsten, scandium, and antimony were among those radionuclides concentrated through roots of plants grown on ejecta from the Sedan thermonuclear cratering detonation. Nuclear reactor-produced isotopes were used in corroborative experiments to investigate, in greater detail, their behavior in plants and soils. Radiotantalum was also included as a matter of academic interest. Plants concentrated more ^{46}Sc, ^{124}Sb, and ^{185}W in leaves than in stems, whereas ^{182}Ta was concentrated more in stems. Plant uptake of ^{46}Sc, ^{124}Sb, and ^{185}W was influenced by different types of soil. Scandium-46 and ^{182}Ta were virtually immobile in columns of soil leached with 76 cm of water while ^{124}Sb and ^{186}W moved readily in neutral and alkaline soil, but not in acidic soil. Their behavior was influenced by the kind of clay mineral present, the sodium and potassium content, and the soil pH. (auth)

Facilities and Equipment

Refer also to abstracts 16420, 16873, and 16874.

16040 (AEEW-M-699) THE USE OF A COMPUTER AND A TAPE-CONTROLLED DRILLING MACHINE, FOR THE PRODUCTION OF FUEL ASSEMBLY CLUSTER PLATES. Hilton, R. K.; Wells, G. M. (Atomic Energy Establishment, Winfrith (England)). Sept. 1966. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Improved techniques which are now in use for the design and manufacture of complex fuel assembly cluster plates for zero-energy reactors are described. Laborious hand calculation of hole coordinates has now been replaced by a computer program written in FORTRAN which optimizes the physics design and prints out the rectangular coordinates of each hole. A subroutine POT has been prepared which enables the KDF 9 computer to produce the 5-hole standard paper tape used to feed the tape-controlled drilling machines. (UK)

16041 (IITRI-578P21-27) EXPERIMENTS AND ANALYSIS ON THE PERFORMANCE OF CRUSHABLE BLAST SHIELDS. Zaker, T. A.; Lieberman, P. (IIT Research Inst., Chicago, Ill.). June 1966. Contract AT(11-1)-578. 38p. (CONF-660650-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From European Nuclear Energy Agency CREST Meeting, Ispra, Italy.

A strong shock tube was used to generate pressure loadings on the end surface of a length of crushable solid material. Measurements were made on wave velocities in the solid, and on pressure loadings at the gas-solid interface and at the rigidly supported end surface of the solid. The results were analyzed to determine stress-specific volume relations under conditions of uniaxial strain in shock loading, unloading, and repeated recompression. Experiments were performed on six porous materials, including natural woods and artificial foamed materials. The resulting equation of state data are essential in the analysis of stress attenuation in layered crushable blast shields. A method of analysis of wave propagation in layered shields was devised based on a piecewise linear approximation of the stress-specific volume relations for crushable materials. A computer program was developed to calculate wave motion in a layered composite of crushable materials using the piecewise linear representation of material properties. Results for simple two-layer composites show that attenuation of short-duration pressure loads by a factor of ten is possible in a 10-in. shield. (auth)

16042 (LF-34) DESIGN AND CALIBRATION OF A MODIFIED CONIFUGE. Tillery, M. I. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Jan. 1967. Contract AT(29-2)-1013. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A modified centrifugal sampling instrument for airborne particulates of the type developed by Sawyer and Walton is described. The modifications permit controlled introduction of

clean air and a method of collecting the sample on electron microscope grids for examination. Construction details of the modifications are included. Experimentally determined calibration curves for 3000, 4000, and 5000 rpm are given, together with electromicrographs of typical deposits. (auth)

16043 (NAA-SR-Memo-11350) BOMPUP—SNAP 2 THERMOELECTRIC BOILING MERCURY PUMP MODEL. Bramblett, Elizabeth L. (Atomics International, Canoga Park, Calif.). May 1965. Contract AT-11-1-GEN-8. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

BOMPUP, a computer code to simulate a boiling Hg pump, is written in FORTRAN IV for use on the IBM-7094. While many of the properties of the SNAP-2 boiling Hg thermoelectric pump are known, some are not. The BOMPUP model views the pump as a series of adjoining sections. By computing the qualities of each section, the pump qualities can be determined. Temperature and pressure changes across the pump, the diffuser pressure drop, hydraulic losses, pressure drop, and pump developed pressure are computed by iteration between pressure and temperature. (F.S.)

16044 (ORNL-4047) CHARACTERIZATION OF RADIOACTIVE PARTICULATE AEROSOLS BY THE FIBROUS FILTER ANALYZER. Silverman, M. D.; Truitt, J.; Browning, W. E. Jr.; Franzen, L. F. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 64p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The fibrous filter analyzer (FFA) has been developed for measuring the characteristics of radioactive aerosols in terms of their response to filtration processes by determining their distribution vs depth in a filter under carefully controlled conditions. Moisture did not significantly affect the performance of the FFA, although the test aerosol itself was affected. The filtration efficiency data agreed well with the theoretical treatment of filtration developed by Torgeson. The analyzer was calibrated against particles of 150 to 1500 Angstroms in diameter, measured by electron microscopy. (auth)

16045 (Y-EF-22) EVALUATION OF SEAT MATERIALS FOR PRESSURIZER STEAM RELIEF VALVE. Weathersby, W. E.; Lambert, F. J. Jr.; Dunn, E. E.; Googin, J. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Nov. 1, 1966. Contract W-7405-eng-26. 100p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An investigation was made to improve the leak tightness of commercial steam pressure relief valves such as required in a steam pressurizer used as part of a reactor control system. Laboratory studies and leak tests were carried out on various materials including noble metals and their alloys, Stellites, tungsten carbide, and aluminum oxides. The effects of surface finishes and piping configurations were evaluated. None of the materials tested met all the requirements for leak-tight seating surfaces under the specified condition of repeated valve relieving. However, tests of limited duration indicated that the Stellite and tungsten carbide seating surfaces were leak-tight until the valve was relieved. It is theorized that a cermet of aluminum oxide with a small percent of platinum as a binder is worth future investigation. (L.C.L.)

16046 (ORNL-tr-1484) HWM-KLEIN MANIPULATOR, A 201 AND A 200. Waelischmiller, Hans. Translated for Oak Ridge National Lab., Tenn., from a Brochure Issued by Meersburg/Bodensee, Germany. 15p. Dep. mn. JCL $1.60 fs, $0.80 mf.

Three series of the HWM-Klein manipulators, the A 100, A 200, and A 201 are described. These manipulators are solid, heavy duty, versatile and easy to manage. The A 100 consists of three easily replaceable main parts; the hot arm, the cold arm, and the wall duct. The wall duct can be unsealed or gas-tight. The A 201 is suitable for installation heights of 1850 to 2250 mm; the A 200 is used for lower heights. The A 100 can be used with various hot cell heights. (F.S.)

16047 STAINLESS STEEL TANKS FOR RADIOACTIVE WASTE STORAGE. Hoffman, T. L. (Idaho Nuclear Corp., Idaho Falls, Idaho). Mater. Protect., 5: No. 10, 13-15(Oct. 1966).

Stainless steel tanks, used for long-term interim storage of acidic, radiochemical wastes prior to solidification by fluidized bed calcination are described. The tanks are contained in concrete vaults underground. Tanks are tungsten inert gas welded. Stainless steel tanks were chosen because of prior corrosion studies. To ensure continued safety in using the tanks, the long range plant testing program is being continued. General corrosion rates observed are too low to estimate the vessel life; minor evidence of localized attack is not severe enough to define a mechanism of probable failure. Careful surveillance should quickly detect early accelerated localized attack or other signs of failure. (F.S.)

16048 EARTHQUAKE-PROOF DESIGN OF MECHANICAL STRUCTURES: IN RELATION WITH THE ATOMIC POWER PLANTS. Shibata, Heki; Sato, Toshiyoshi (Tokyo Univ.). Seisan-Kenkyu, 17: No. 11, 8-19(Nov. 1965). (In Japanese).

The design of earthquake-proof mechanical structures particularly for atomic power plants is discussed. The characteristics of earthquake shock waves depend on the geology of the area affected and must be analyzed for the vibration effect on a particular structure at a specified location. Flexure measurements were made at the center of gravity of a simulated structure having one degree of freedom and a known applied load. The theoretical vibration characteristics of an atomic power plant piping system were obtained by computer by analyzing segments of the piping system such as straight, bent, support, and joined parts. The maximum period of vibration of the foundation and the response of the structure were analyzed using the irregular vibration theory. Heat and bending moment stresses were considered along with the earthquake stresses. Fatigue due to frequency of vibration was evaluated. The overall stresses calculated were compared with the permissible stress values determined by the tensile strength, yield point, elastic limit, and fatigue strength of the mechanical structure. (TSS)

16049 ANALYSIS ON U-TYPE BELLOWS. Nakamura, Yasuharu (Yokohama National Univ., Japan); Takahashi, Yukihiro. Nippon Kikai Gakkai Rombunshu, 32: 555-68(Apr. 1966). (In Japanese).

Bellows used in the piping of a nuclear reactor system were studied for the effect of material, shape, size, strength, dynamic behavior, and ease of fabrication. The theoretical analysis of the deformation of the bellows was based on the plate bending theory assuming a minute deformation. Different shapes of commercial bellows were examined, and tested under static loads. The test results agreed well with the values calculated by the bending theory, and the calculations were confirmed as usable. A special repeated-load tester was constructed to determine the strength of the bellows. Bellows made of SUS 43 (AISI 347) and Cr–Mo steel, in the same shape as those in the static tests, were tested with the repeated-load tester at high stress and low cycle. Further tests on the effects of sizes and shapes of bellows are necessary. (TSS)

16050 MODEL REFERENCE ADAPTIVE CONTROL OF A NUCLEAR ROCKET ENGINE. Humphries, Jack Thomas. Gainesville, Fla., Univ. of Florida, 1966. 134p.

Thesis.

Parameter adjustment model reference adaptive control of a nuclear rocket engine is investigated. The engine considered is similar to the solid-core, 25,000 megawatt, million pound thrust model developed by Smith and Stenning. Proportional control gain for the control poison, i.e., rods or drums, is the parameter adaptively adjusted, and maximum core surface temperature is the adaptively controlled variable. Acceptable engine performance is achieved by using a second-order model with one finite zero. Engine response to step commands is particularly sensitive to change in the system's pressure time constant. With constant-parameter control, doubling this time constant results in doubling the system's transition time from an idling condition to full power. Adaptive control for the same condition achieves a transition time within 20 per cent of the desired, or "normal," response. Estimates of propellant savings with adaptive control are given, and dynamic stability of the system is discussed. (Diss. Abstr.)

16051 METHOD OF STABILIZING A FLUIDIZED BED USING A GLOW DISCHARGE. Katz, H. (to U. S. Atomic Energy Commission). U. S. Patent 3,304,249. Feb. 14, 1967.

A process for producing a stabilized fluidized bed in a vessel having a fluidized bed of particulate solids is described. The solids have a moderate surface electroconductivity. A high voltage is applied to at least a portion of the bed in an amount sufficient to cause a corona discharge in the bed. (AEC)

16052 DAMPED BEARING FOR CENTRIFUGES. Barringer, H. P. (to U. S. Atomic Energy Commission). U. S. Patent 3,306,681. Feb. 28, 1967.

A damped bearing is described for centrifuges wherein a self-aligning spherical bearing arrangement is pivotally mounted to provide a self-aligning feature, and a vibration damping ring is attached to the outer race of the spherical bearing, the ring having outwardly extending lateral projections which cooperate with inwardly extending lateral projections attached to a base member to provide linear damping by a shearing action of an oil layer disposed between the cooperating and overlapping lateral projections. Sealing means are provided to maintain a damping oil around the ring and between the overlapping lateral projections. (AEC)

16053 X-RAY FILM PROJECTOR (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1552).

13 drawings.

The x-ray film projector permits a small audience to clearly see, at a magnification of 5, the image detail of a 3¾ in. sq portion of a film up to 14 by 17 in. in size. Details remain clear even when the average image density is as high as 3 and in the presence of normal illumination. (For details see TID-4100, Suppl. 39). (F.S.)

16054 THREE ROLL TUBE REDUCER (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1549).

125 drawings.

The number of processing steps between tube-blank (secondary) extrusion and finished tubing have been significantly reduced by the three-roll reciprocating tube reducer. During each forward stroke, the three rolls converge on the tube and reduce the wall thickness 50% in a single operation at ambient temperatures, eliminating several conventional draw passes. Heavy wall reductions are made over a hardened steel mandrel. The tube reducer was designed to be used in fabricating V–Ti–Cr alloy tubing for fast reactor fuel jackets. The tube reducer may be used on conventional and nonconventional tubing materials. (F.S.)

16055 METHODS OF FLUID MEASUREMENT WITH RADIOACTIVE TRACERS. Hull, D. E. (to California Research Corp.). Canadian Patent 747,483. Nov. 29, 1966.

A small quantity (< one millicurie) of radioactivity miscible or soluble is introduced into a fluid system. Its transit through a predetermined part of the system may be measured accurately and fluid flow calculated. The method is useful for calibrating meters in place and for detecting solid deposits which restrict flow especially in welded piping where access is difficult. A fairly complex detection circuit is required. (F.S.A.)

16056 CONTROL FOR A NEUTRON GENERATOR. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1966-4919. Mar. 17, 1966. Filed Oct. 16, 1963.

A control device is proposed which allows neutron irradiation to be done efficiently in a neutron generator. The device is installed for detecting the entrance and removal of a target material with regard to the irradiation facility and by the use of the signals from this detector, the switch for the power source for the ion source is opened or closed. Thus, only when a sample material is in the irradiation room, are ions emitted from the source. The result is that the accelerated ion beam is produced only when required, thus leading to a higher efficiency of the operation of a neutron generator and to the elimination of local overheating. (NSA of Japan)

16057 IMPROVEMENTS RELATING TO PHOTOGRAPHIC APPARATUS. (to Cedars of Lebanon–Mt. Sinai Hospitals of the Los Angeles Jewish Medical Center). British Patent 1,055,852. Jan. 18, 1967. Priority date Apr. 27, 1964, United States.

A medical diagnostic device used to record the distribution of radioactive isotopes in the body by photographic color scanning is described. The device is comprised of a radiation detector and a traversing mechanism for the detector, a holder for a photosensitive sheet, means for producing a spot of illumination with an oscilloscope, means for causing the illumination spot to move relative to the photographic sheet in accordance with the motion of the detector, and a means for changing the color characteristics of the illumination spot in response to the response level of the detector. (F.S.)

16058 GRIPPING APPARATUS INCLUDING A TELEVISION CAMERA. (to Societe Alsacienne de Constructions Atomiques de Telecommunications et d'Electronique Alcatel and Societe de Transactions Commerciales et Industrielles Entre la France et l'Allemagne S.O.T.R.A.F.A.). British Patent 1,058,851. Feb. 15, 1967. Priority date Apr. 5, 1963, France.

A remotely controlled manipulator and viewing apparatus is described which may be used for manipulating drilling tools and fuel slugs in reactor channels. The equipment consists of an electromagnetic gripping tool and an endoscope in a steel casing which also contains a second steel casing within which a television camera is mounted. The camera receives its image through the endoscope. Lighting is provided at the free end of the endoscope. A third casing, connected to the second casing, is filled with a cooling fluid. Cables for the current supply and the television cable are located in this casing. The improvements in the equipment permit economical operation and maintenance since it is possible to operate the equipment without shutting the reactor down. (F.S.)

16059 SYSTEM FOR DISTRIBUTING SAMPLES. Galame-Longjean, Andre; Guillet, Henri (to Commissariat a l'Energie Atomique). British Patent 1,059,903. Feb. 22, 1967. Priority date Mar. 6, 1964, France.

A system is described which is used in distributing samples, particularly radioactive samples, whose contact with the atmosphere might be harmful to the samples or to the operators. The system consists of a central elevated casing adapted to receive the samples which are in polythene vials. The vials are transferred by gravity from the central casing in tubular conduits to the glove box for analysis. The samples are then sent to a receiving basket to be raised later into the central casing. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 16588 and 16849.

16060 (AEEW-R-479) AN EXPERIMENTAL INVESTIGATION OF FORCED CONVECTION BURNOUT IN HIGH PRESSURE WATER. PART IV. LARGE DIAMETER TUBES AT ABOUT 1600 P.S.I. Lee, D. H. (Atomic Energy Establishment, Winfrith (England)). Nov. 1966. 70p. DTIE. HMSO 11s.

Results of 727 burnout tests for tubes with uniform and non-uniform axial heat flux profiles are presented. Most of the data are at 1600 psi although there are some at 1250 and 1800 psi. Tube diameters ranged from 0.5 to 1.8 inches. A new correlation for uniform flux data at these pressures is presented, having R.M.S. errors between 4 and 6%. A table of constant terms for this new uniform flux correlation is given, together with Macbeth's values for pressures of 560, 1000 and 2000 psi. Experimental and predicted burnout powers for non-uniform axial heat fluxes are compared and the existing methods of prediction are found to be in error by up to 20%. A new method for predicting burnout with non-uniform axial heat flux is developed, which correlates all published data to an R.M.S. error of 6.7%. (UK)

16061 (EURAEC-1545) SWIRL FLOWS IN BOILING WATER. STUDY OF CRITICAL FLUX IN SWIRL FLOW IN A CLUSTER OF FOUR RODS. Special Report No. 22. Rosuel, A.; Sourioux, G.; Cheron, C.; Dolle, J.; Sandrin, J. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). Oct. 19, 1965. Contract 061-64-7-TEEF (RD). 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Tests showed that the curves representing critical flux in a cluster as a function of the quality are similar to those obtained in tubes. The phenomena are therefore of the same kind. The influence of the velocities corresponds, in both cases, to an increase in the critical flux. On the other hand, comparison of these fluxes and those obtained in straight flow leads to different conclusions. It appears necessary to continue tests in rod clusters, as the results in tubes cannot be connected directly to other geometries. Initial tests show that, in the case of a cluster of four rods, and for fluid flowing under the operating conditions of a boiling water reactor (sub-saturated fluid at the inlet-mass velocities between 1000 and 2500 $kg/m^2 \cdot sec$), a flux increase of the order of 100% may be expected. The use of discontinuous twisted tapes does not give such an increase in the critical flux. At saturation point the gain reaches 68%. Furthermore, if it became necessary to maintain play between the rods and the twisted tape, it is conceivable that the efficiency of the method would be impaired, as the liquid film would no longer be rotated. (auth)

16062 (SC-CR-66-2128) FEASIBILITY STUDY ON SMALL PARTICLE ABLATION USING A FREE-FLIGHT RANGE. Collins, Daniel J.; Sangster, David K.; Rogers, Walter K. (General Motors Corp., Santa Barbara, Calif. Defense Research Labs.). Nov. 1966. Contracts AT(29-1)-789; 48-4587. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., [Albuquerque, N. Mex.].

The feasibility of using a free-flight range to investigate the reentry behavior of small spherical particles (400 to 700 microns diameter) was experimentally investigated. Using laser photography, information was obtained of shape changes of particles in flight. Under the conditions of the experiments, it is concluded that Al_2O_3 spheres fragment as a result of thermal stresses. (auth)

16063 VAPOR VOLUME PROFILES IN DEVELOPING TWO-PHASE FLOW. St. Pierre, C. C.; Bankoff, S. G. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.). Int. J. Heat Mass Transfer, 10: 237-49(Feb. 1967).

Transverse void fraction distributions and axial cross-sectional average void fraction data have been obtained for a rectangular flow channel at elevated pressures employing the γ-attenuation technique. The ability of several cross-sectional models and correlations to predict the axial average void distributions has also been tested. The development of void profiles in both the axial and transverse directions in a flowing two-phase system is of current interest. (auth)

16064 CALCULATION OF FLOW RESISTANCE OF PASSAGES BOUNDED BY A COMBINATION OF ROUGH AND SMOOTH

SURFACES. Wilkie, D.; White, L. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). J. Brit. Nucl. Energy Soc., 6: 48-62(Jan. 1967).

A set of equations is derived which forms the basis of methods of applying transformed roughened surface friction factor data to the calculation of mixed surface pressure drop. Detailed examples of the methods applied to annular and cluster configurations are presented and the results are compared with experimental values. The study was made in connection with the AGR. (auth)

16065 FILM BOILING OF SATURATED NITROGEN FLOWING IN A VERTICAL TUBE. Laverty, W. F. (Carnegie Inst. of Tech., Pittsburgh); Rohsenow, W. M. J. Heat Transfer, 89: 90-8(Feb. 1967).

Film boiling of a saturated nitrogen flowing upward through a uniformly heated tube was studied. Visual experimental observations demonstrate that the annular flow regime which exists at very low qualities is broken up at higher qualities to form a dispersed flow of liquid droplets in a vapor matrix. Analysis of experimentally determined tube wall temperature distributions shows that a significant amount of vapor superheat is present throughout the film-boiling process. A method is presented by which both an upper bound and an estimated value of the heat transfer coefficient for the dispersed flow regime may be calculated. (auth)

16066 TWO-PHASE FLOW AND HEAT TRANSFER. Hewitt, G. F.; Leslie, D. C. Engineer, 233: 298-302(Feb. 24, 1967).

The present state of knowledge on two-phase flow and heat transfer with particular reference to the design of boiling water reactors is reviewed. The various systems in which two-phase flow can occur are discussed and a review is given of the factors which govern vapour nucleation in an evaporating system. The regimes of flow and heat transfer, which are present in boiling systems, are reviewed and the problem of burnout is discussed. Finally, some other two-phase problems which are of interest in such reactors are listed. While good progress has been made in recent years there are still large areas of major uncertainty and it seems that much further work will be necessary. (auth)

16067 RANDOM THERMOELASTIC STRESSES WALLS CAUSED BY TEMPERATURE FLUCTUATIONS. Ibragamov, M. Kh.; Merkulov, V. I.; Subbotin, V. I. At. Energ. (USSR), 21: 513-14(Dec. 1966). (In Russian).

Factors, such as hydrodynamic instability, phase transformations, and turbulent temperature fluctuations in flowing liquids may induce temperature pulses in walls, through which heat is transferred under stationary thermal conditions, with longitudinal liquid flow. The stresses generated may be quite substantial and under special conditions, such as high heat loads, stress concentrations, corrosive action of the heat transfer agent, they must be taken into account when calculating fatigue resistance. To accomplish this, an approximation method was developed for determining the level of random thermoelastic stresses due to temperature fluctuations at the boundary. The problem was solved for thin layers, assuming that the field distribution of random temperature across the layer is linear, and both the temperature and stress fields depend on a single variable, the time. As the experimentally determined pulsation frequency spectrum was found to be low, –0.05 to 5 hertz, a quasistatic method could be used. The formulas derived made it possible to estimate the longitudinal stresses generated by temperature pulsation in heat transferring systems. For systems operating at the maximum permissible stress level, the supplementary stress does affect the structural integrity. (TTT)

16068 STUDY OF THE HEAT TRANSFER OF BOILING SODIUM UNDER CONDITIONS OF FREE CONVECTION. Deev, V. I.; Dubrovskii, G. P.; Kokorev, L. S.; Novikov, I. I.; Petrovichev, V. I. At. Energ. (USSR), 22: 49-51(Jan. 1967). (In Russian).

The lack of experimental data on the heat transfer of boiling sodium makes it difficult to determine the range, within which the operation is unstable; therefore, a series of heat transfer tests were carried out on the boiling of sodium in bulk, varying the pressure and heat load conditions within broad limits. The liquid pool was heated by means of an immersed steel disc subjected to electron bombardment; the system was calibrated by measuring the heat transfer of distilled water in the same device. The results indicated that at low pressures, e.g., $p \cong 6 \times 10^2$ n/m^2, no surface boiling occurs throughout the whole heat-load range and the heat transfer takes place only by convection. In the 4×10^3 to 2×10^4 n/m^2 range, the boiling process was unstable, exhibiting strong temperature fluctuations. At the upper limit of the above-mentioned pressure range, the boiling became stable, with a minimum of temperature fluctuations. These results do not agree with those reported by R. Lyon et al. (TTT)

16069 AN INDEX TO THE TWO-PHASE GAS-LIQUID FLOW LITERATURE. Gouse, S. William Jr. M.I.T. Report No. 9. Cambridge, Mass., Massachusetts Institute of Technology Press, 1966. 873p. $15.00.

A bibliography of 5253 publications on two-phase gas-liquid flow has been compiled. The references are listed by subject according to problem area or application, or both. The major subject areas are boiling, bubbles, capillary tube, closed loops, compressible flow phenomena, flow oscillation, gas lift pump, two-phase flow, void fractions, and miscellaneous. (L.C.L.)

Isotope Technology

16070 (EUR–3252.f) ETUDE PRELIMINAIRE A LA MISE AU POINT D'UNE SOURCE DE NEUTRONS A BASE DE PRODUITS DE FISSION (EURATOM NEUTRON SOURCE). (Preliminary Study to the Development of a Neutron Source with a Fission-Product Basis (Euratom Neutron Source)). Godar, S.; Verfaillies, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Jan. 1967. 14p. (In French). Dep. mn.

Preliminary tests relating to the use of fission products, such as $^{144}Ce-^{144}Pr$ and $^{106}Ru-^{106}Rh$, for the fabrication of neutron sources are described. Judging from the results obtained, these sources have certain advantages (higher neutron flux, longer half-life and low cost) over those with a basis of ^{124}Sb. (tr-auth)

16071 (NEIC-RR-15(Pt.1)) RADIOIZOTOPY W PRZEMYSLE. CZESC I. REFERATY ZBIORCZE WYGLOSZONE NA II KRAJOWYM SYMPOZJUM ZASTOSOWAN IZOTOPOW PROMIENIOTWORCZYCH W TECHNICE, SPALA, 16–19 PAZDZIERNIKA 1963 R. (Radioisotopes in Industry. Part I. Second National Symposium on Technical Use of Radioisotopes, Spala, October 16–19, 1963). (Nuclear Energy Information Center, Warsaw (Poland)). 1965. 186p. (In Polish). (CONF-631010(Pt.1)). Dep. mn.

Ten papers are presented on the industrial applications of radioisotopes. Economic aspects of the industrial utilization of radioisotopes and radiometric methods and instrumentation used in physical and chemical analyses and research, and principles and practices of spectrochemical analysis are discussed. (R.V.J.)

16072 (NYO–3736-2) MICROBIAL INHIBITION SYSTEMS EMPLOYING RADIATION (MISER). Kivel, Joseph; Chatterton, Margaret S.; Palchak, Robert J. F. (Atlantic Research Corp., Alexandria, Va. Nov. 1966. Contract AT(30-1)-3736. 76p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An evaluation of potential industrial uses of a radiation processing system for inhibiting microbiological growth in nonfood applications has indicated economic feasibility in several areas. These include the use of radiation to inhibit microorganism growth in fuel holding tanks, jet fuels, cutting fluids, cosmetics, and body fluids such as blood. The required curies of ^{60}Co for each area is specified. Certain applications were found to be uneconomical. These include paints, municipal swimming pools, drilling mud, and animal glue. Applications appear to exist in the control of fungal contamination in textiles, in soap wrapper sterilization to prevent mold growth, and in fouling prevention of marine systems by radioactive coatings. (F.S.)

16073 RADIOISOTOPES SPEED FIRE DETECTION. Dance, J. B. (Univ. of Aston, Birmingham, Eng.). Instrum. Pract., 20: 975-8(Dec. 1966).

The use of radioisotopes in smoke detection devices is reviewed. Smoke detectors employ ionization chambers containing a small source of α radiation (usually ^{226}Ra or ^{241}Am) of 10 to 100 μCi in activity. If smoke enters such a chamber, some of the ions formed in the air by the α radiation will approach smoke particles and give up their charge. Thus when smoke enters an ionization chamber, the current passing through the chamber tends to decrease. An additional very small reduction in the ionization current is due to the absorption of the α radiation by the smoke particles. Two ionization chambers are employed in the smoke detecting devices. The wall of one is of wire mesh through which the smoke particles can enter, but the other chamber is closed. Changes which occur in the circuit potentials when smoke particles enter the open chamber applied to a trigger electrode cause the gas in the tube to ionize. The resulting anode current (about 15 mA) operates a relay which in turn actuates warning devices and any fire extinguishing equipment. The ionization chamber detector is sensitive to particles larger than air molecules. Such particles are often too small to be visible as wisps of smoke. (BBB)

16074 RADIOACTIVE PROCEDURES FOR MEASUREMENT OF FILM THICKNESS. PART V. Kosbahn, Thomas (Arolsen, Kreis Waldeck, Ger.). Arch. Tech. Messen., No. 371, 365-8(Dec. 1966). (In German).

Thickness measurements of fluids in tubes using β and γ radia-

tions are discussed and illustrated. These measurements are used in the petroleum industry to follow flow and mixing of fuel components. Measurement uncertainty is plotted as % of density for ^{90}Sr, ^{137}Cs, and ^{60}Co. Doses at various distances are plotted for ^{147}Pm, ^{204}Tl, and ^{90}Sr. Factors such as the no. of curies, type of radiation, max energy, frequency of γ radiation, half life, and shielding conditions that effect the radiation hazard from thickness measurement procedures are discussed. Pertinent industrial procedures to ensure safe use of high intensity radiation sources are presented and discussed briefly. Forty three references are cited. (BBB)

16075 SELECTION OF A RADIATION SOURCE FOR IRRADIATING BULK MATERIALS. Bibergal', A. V.; Primak-Mirolyubov, V. N. At. Energ. (USSR), 22: 55-8(Jan. 1967). (In Russian).

The effectiveness of irradiation of grains and potatoes to kill insect pests and to prevent germination has been well established. The process is best carried out by moving the materials continuously in front of a radiation source. Geometrical considerations play an important role in ensuring a constant absorbed dose throughout the bulk of the material. The cylindrical configuration was more closely examined, determining the efficiency of the system on the basis of the total activity of the central source and the distance of the moving material. The calculations indicated that about 30% of the radiation energy may be absorbed usefully. The efficiency of an irradiating system consisting of a single linear source was found to be lower than that of a more complex system. Only qualitative conclusions could be drawn because "dead angles," reaching areas free from material to be irradiated, were not taken into account. (TTT)

16076 COUNT RATE BALANCE METHODS USING RADIOACTIVE TRACERS FOR MEASURING SEDIMENT MASS FLOWS. Courtois, G.; Sauzay, G. (Centre d'Etudes Nucleaires, Saclay, France). Houille Blanche, 21: 279-90(1966). (In French).

A new radioisotope method is presented for using tracers to study the movement of stream bed sediments. Conventional radioactive tracer equipment is used. Iridium-192 and tantalum-182 were buried in the sediment. By measuring the width of the moving mass and bulk density of the sediment, the velocity of the moving mass could be determined as a function of the detector count rate. The use of several detectors improved the accuracy of the method. Experiments were performed in two rivers in France. The rate of sediment flow during flooding, determined by the tracer method, was estimated to be within 25% of previous estimates. (BBB)

16077 INVENTORY OF THE QUANTITY OF MERCURY IN AN INDUSTRIAL CHLORINE CELL USING A RADIOACTIVE MERCURY TRACER. Cowley, W. E.; Lott, B.; Brown, S. (Associated Octel Co., Ltd., Ellesmere Port, Eng.). Chem. Eng. (London), No. 204, 345-9(Dec. 1966).

A radioactive-tracer technique is described for the accurate metering of metallic mercury tied up in industrial chlorine-caustic cells. The main advantage of the tracer method is that there is no costly interruption in production during the Hg inventory, as in the alternative method of draining and weighing where all the cells have to be shut down simultaneously. The preparation of a relatively inexpensive mixture of mercury isotopes (^{197}Hg, ^{197m}Hg, ^{203}Hg) in a nuclear reactor, for use with this method, is also described. Radiation hazards, associated with this technique, and their prevention, are considered. With the mixture of isotopes used, ^{197}Hg predominates, with a half-life of 65 hr, permitting a Hg inventory to be taken every 6 months. The method consists of adding a known weight of radiomercury to a cell and allowing sufficient time for it to mix homogeneously with the natural mercury in the cell. A sample of Hg is taken from the dosed cell, its radioactivity counted, and by comparison with the radioactivity of a standard dilution, the original content of Hg in the cell can be computed. The mercury was saturated with the 197 and 197m isotopes (200 mCi/g) and also contained 7.5 mCi/g of the 203 isotope. Prolonged irradiation over one week only slowly increased the concentration of the 203 isotope. In the experiments described 15 mCi was added to each cell which contained about 1500 Kg of mercury to give an activity in the cell of 1 mCi/100 g. In the assessment of health hazards, it is pointed out that the isotope used, mainly ^{197}Hg, has a soft γ-ray emission, but even so it was important to keep the time of handling the silica ampoules to a min. Mercury in air was monitored and, in the initial handling, rubber gloves were worn and film detector badges displayed. (BBB)

16078 LES RADIOELEMENTS. PRODUCTION, DOSAGE, APPLICATIONS. (The Radioelements. Production, Dosage, Applications). Blanc, Daniel. Paris, Masson et Cie, 1966. 290p. 59 F.

A book, written for the researcher, engineer, or doctor, not having any special knowledge in the field of radioisotopes, is presented. The mathematics are simplified. The basic concepts of nuclear physics are first outlined. The principal procedures used for the production of radioelements are described. The particle detectors, associated circuits, and measurements of radioactivities are discussed. The dangers presented for the use of radioelements and the maximum permissible doses are considered. Examples are given of practical uses of radioelements. (J.S.R.)

16079 INDEXING MECHANISM FOR IRRADIATING PACKAGES. Volonakis, A. T. (to U. S. Atomic Energy Commission). U. S. Patent 3,305,683. Feb. 21, 1967.

An indexing mechanism for positioning, in succession, packages for exposure to radiation is described. The packages are guided by the indexing mechanism over a pit in which flat cobalt-60 sources are located. The packages are placed in spaced positions and the sources are raised into the spaces between successive packages. After a predetermined period of exposure the sources are retracted and the packages are indexed ahead to successive positions for removal or further irradiation. (AEC)

16080 IMPROVEMENTS IN OR RELATING TO NUCLEAR-POWERED ELECTROMAGNETIC SIGNAL GENERATORS. (to Saint-Gobain Techniques Nouvelles). British Patent 1,058,678. Feb. 15, 1967. Priority date June 7, 1963, France.

A ^{90}Sr isotopic signal generator which is used in producing electromagnetic radiation in the form of successive impulses is described. A capacitor is provided to store energy produced by the nuclear generator. Periodically the stored electric energy is converted into radiation impulses through an electromagnetic radiation generator which emits very high frequency radiations. The nuclear generator may be used for a beacon or for a submarine detection buoy. (F.S.)

16081 MEASUREMENT OF DENSITIES OF ALKALI METALS IN THE REGION OF THE CRITICAL POINT BY A GAMMA RADIATION COUNTING TECHNIQUE. Dillon, Ira G. Chicago, Illinois Inst. of Tech., 1965. 97p.

Thesis.

The critical temperature and critical densities of alkali metals were determined by a gamma radiation counting technique. The vapor and liquid densities of sodium, potassium, rubidium, and cesium were measured from room temperature to near the critical point. The measurement procedure is described in detail. The results are compared with several experimental and theoretical predictions for the critical temperature and densities of these metals. This study showed that the alkali metals deviate from the "law of corresponding states" based on nonmetallic substances. The method is applicable to the determination of high temperature vapor and liquid densities of metals, mixtures of metals, fused salts, liquids, and other materials. (Diss. Abstr.)

Materials Testing

16082 (ANL-7262) TESTS OF COMMUTATING BRUSHES FOR USE IN D.C. MOTORS OPERATING IN A DRY ARGON ATMOSPHERE. Slawecki, M. A.; Bernstein, G. J.; Coleman, L. F. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tests of commutator brushes for use in dc motors operating in a dry argon atmosphere were made to determine the best brush material for minimum wear and the effect on brush wear of moisture and oxygen in the cell atmosphere. The dc motors used were the same type as used for driving the Fuel Cell Facility manipulators. The lowest wear rate was obtained with a resin-bonded carbon-graphite brush containing 5% molybdenum disulfide (Stackpole Grade 660). In atmospheres containing 1.7 to 21 ppM moisture and less than 50 ppM oxygen, the highest wear rate for this grade brush was 0.0189 in./hr. The Stackpole Grade 660 brush material is being used successfully on manipulator drive motors in the Argon Cell of the Fuel Cycle Facility. (L.C.L.)

16083 (KAPL-M-6582) FINEL, A PROGRAM TO SOLVE ELASTIC STRUCTURES BY THE USE OF FINITE ELEMENTS. Jordan, W. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1, 1966. Contract W-31-109-eng-52. 87p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

FINEL is a collection of three programs on the CDC-6600 for the calculation of the elastic and plastic behavior of structures based on the finite element approach. The structures are built up from plates and bars, which can be arranged in either 2-dimensional or 3-dimensional assemblies. The plates can be in plane stress or plane strain. FINEL-2 handles 2-D structures only. FINEL-3 can handle both 2- and 3-D, but is slower. FINPUT is an aid for the preparation of input to the FINELs. (auth)

16084 (SWRI-1228-1-36(Pt.2)) STUDIES OF THE FATIGUE STRENGTH OF PRESSURE VESSELS. PART II. PREDICTION OF THE LOW CYCLE FATIGUE LIFE AND TERMINAL FAILURE BEHAVIOR OF PRESSURE VESSELS. Technical Summary Report. Pickett, A. G.; Grigory, S. C. (Southwest Research

Inst., San Antonio, Tex.). Feb. 1967. Contract AT(11-1)-1228. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work on cyclic pressure tests of full-size pressure vessels has been summarized and presented. Discussions and results of investigations of crack initiation and propagation and terminal failure of the vessels are presented. (auth)

16085 FATIGUE APPARATUS FOR EXTREME HIGH VACUUM. Reed, Malcolm E.; Hordon, M. J. (National Research Corp., Cambridge, Mass.). Contracts NASw-962; NASw-1231. Rev. Sci. Instrum., 38: 322-5(Mar. 1967).

A constant amplitude, reverse bend stress fatigue testing device is described which permits simultaneous testing of up to eight specimens at extremely low pressure levels below 10^{-10} Torr. The vibratory force was provided by an electromagnetic exciter with vibration frequencies in the range of 50–200 cps. Fatigue tests with 1100-H14 aluminum showed that a substantial increase in the cyclic fracture life was obtained in high vacuum as compared to the fatigue behavior in unit atmosphere of air. The fatigue life improvement increased proportionally with the cyclic stress frequency. (auth)

Radioactive Material Handling

Refer also to abstracts 15995, 15997–15999, 16031, 16046, 16047, 16059, 16307, and 16308.

16086 (STI-PUB-126) DISPOSAL OF RADIOACTIVE WASTES INTO SEAS, OCEANS AND SURFACE WATERS. Proceedings Series. Proceedings of the Symposium held in Vienna, May 16–20, 1966. (International Atomic Energy Agency, Vienna (Austria)). Sept. 1966. 910p. (CONF-660507). IAEA: $18.50; Austrian Schillings 478,- £6.10.6, F Fr 90,70; DM 74,-.

Fifty-six papers on the disposal of radioactive wastes into seas, oceans, and surface waters are presented. Individual abstracts were prepared for 26 papers. One was omitted from NSA. Abstracts of 29 papers appeared previously in NSA 20: 18902, 18903, 20382, 25282, 40479, 40529, 40530, 40573, 40574, 40575, 40578, 40700, 41128, 41140, 41217, 43539, 43540, 43541, 43544, 45223, 45224, 45225, 45227, 45228, 45229, 45910, 47089, 47090, and 21: 8669. (L.C.L.)

For abstracts of individual papers see: 15995–15999, 16030, 16031, 16088–16093, 16302–16310, 16318, 16319, 16459, and 16460.

16087 (SWRI-1262-4) INVESTIGATION OF LOW-LEVEL RADIOACTIVE WASTE CONTAINERS IN AN ACCIDENT ENVIRONMENT. PART I. SURVEY OF TRANSPORT AND DISPOSAL PROCEDURES. PART II. STRUCTURAL INTEGRITY OF TYPICAL LOW-LEVEL RADIOACTIVE WASTE CONTAINERS. Minor, J. E.; Rastrelli, L. U. (Southwest Research Inst., San Antonio, Tex.). Oct. 1965. Contract AT(11-1)-1262. 174p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An investigation was made of low-level radioactive waste disposal and transport procedures, of the design of waste material containers, and of accident environments, such as highway mishaps and fires, which might involve radioactive waste in containers. A comprehensive survey of current disposal practices is presented which provides a basis for evaluating waste container structural integrity. The dynamic forces which may be experienced by a low-level waste container in a highway accident are identified and used for predicting the dynamic responses of typical containers. A comparison of structural integrity properties of typical cylinder and box containers is made. Conclusions relating the effectiveness with which the two container types can withstand an accident are advanced. (L.C.L.)

16088 METHODS OF STUDYING RADIOACTIVE EFFLUENT DISPERSAL IN WATER. Bovard, P.; Grauby, A. (CEA, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 3-10 of STI-PUB-126. (In French).

Methods developed and applied in France for the study of the transfer processes which result from the disposal of low-activity liquid effluents into surface waters are described. The transfer processes include transfer of radioactivity to the surface water and living and inert substances in the water. The methods used concentrate on empirical data only. (L.C.L.)

16089 RADIOACTIVE WASTE DISPOSAL AND INVESTIGATIONS ON TURBULENT DIFFUSION IN THE NETHERLANDS COASTAL AREAS. Van Dam, G. C. (Rijkswaterstaat, The Hague); Davids, J. A. G. pp 233-48 of STI-PUB-126.

Experiments for studying turbulent diffusion near the Netherlands coast have been performed to investigate problems of low-level radioactive liquid waste disposal into the North Sea. Two kinds of experiment were performed in the Netherlands coastal zone, namely, instantaneous-release trials and continuous releases. From sufficient knowledge of instantaneous releases, continuous-release situations may be found by computation. With this procedure, however, complete reliability can only be obtained if the integration of results from a single release is not extended for periods much longer than the duration of the measurements of the instantaneously released matter. This has led to a combination of both experimental techniques linked by mathematical models and electronic computations. A favorable condition for the models is the fact that the Netherlands coast may, in many instances, be considered as a straight line. The combination of computations and experiments has led to a limited theoretical insight and a satisfactory empirical description for predicting concentration distributions at the shoreline and offshore. (auth)

16090 THE UNITED STATES ATOMIC ENERGY COMMISSION'S COLUMBIA RIVER PROGRAM. Wildman, R. D. (Atomic Energy Commission, Richland, Wash.). pp 673-82 of STI-PUB-126.

The Columbia River at Richland, Washington, contains radioactivity from three primary sources: naturally occurring, worldwide fall-out, and from the Atomic Energy Commission's Hanford operations. The small amount of radioactivity in the river of Hanford origin comes primarily from the five production reactors. Stable elements present in the cooling water are transformed into radionuclides during passage through the reactors. Also, radioactive materials formed on the surfaces of fuel elements and channels are eventually carried by the cooling water to the river. As a result of the presence of radioisotopes in the cooling water returned to the river, a continuous evaluation program is maintained. The presence of these isotopes also provides an excellent opportunity to use them as radioactive tags or tracers in many studies in the river, estuary and ocean. In addition to the radioisotopes released from the reactors, ruthenium-106 and tritium are believed to be entering the river after being discharged to the ground from the chemical separations plants. Although detectable in the ground water within a few miles of the river, the amounts of these isotopes added to the river are so small that they are essentially indistinguishable from the radioruthenium and tritium already present in the river. Investigations on the fate and effect of radioisotopes released to the Columbia from the Hanford reactors have been under way since the 1940's. While the early work was devoted to determining the potential effect of the reactor effluent on aquatic organisms, later effort was broadened to include studies on the distribution of various radioisotopes in the river and the ocean, uptake and concentration of several isotopes by aquatic organisms and effects of specific isotopes on certain animals. Of the over 60 radionuclides which have been identified in the reactor effluent water, ^{24}Na, ^{32}P, ^{46}Sc, ^{51}Cr, ^{65}Zn, ^{76}As, ^{131}I and ^{239}Np have received the greatest attention in the various studies. In 1962, the AEC's many separate studies were drawn together for integration and coordination by the Working Committee for Columbia River Studies. This Committee assures that the comprehensive program will provide the desired information without duplication of effort. The present program is described and those studies not discussed by other speakers are reviewed. Also, the highlights of the studies to date are presented in summary form along with a bibliography of the significant publications which report the results of the AEC-sponsored studies. (auth)

16091 RETURN OF WASTE WATER TO THE ENVIRONMENT: THE EXPERIENCE OF SEVEN YEARS OPERATION OF THE MARCOULE PLUTONIUM PRODUCTION CENTRE. Rodier, J.; Estournel, R.; Court, R.; Gallissian, F. (CEA, Centre de Production de Plutonium, Marcoule, France). pp 709-23 of STI-PUB-126. (In French).

Operation of the Marcoule Centre situated on the banks of the Rhone has raised numerous problems in connection with the disposal of waste water. Large resources have had to be applied to treating the effluents and reducing the hazard accruing from them. Analysis of the radionuclides contained in the waste water discharged into the river shows that nearly 90% of the activity is due to the ruthenium-rhodium pair. Radioactive monitoring of the wastes is closely supervised by the Commissariat à l'Energie Atomique and the Ministry of Public Health. On the basis of the recommendations of the International Commission on Radiological Protection, and of a study of the hydrological characteristics of the river, a licensing schedule for radioactive wastes has been established, which fixes the permissible levels of radioactivity. About 1800 Ci are disposed of annually. Following predilution by a factor of 100 the effluents are discharged into the river by a sprayer. The order of magnitude of the overall dilution is about 100,000. This has been checked by tracer experiments (rhodamine and radiotracers). During the seven years' operation of the Marcoule Centre, the monitoring results have never revealed any abnormal increase in the radioactivity of the Rhone water. Indeed, the quantity of radionuclides discharged into the river has always remained below 2% of the levels authorized under the licensing schedule. The possible

fixation of radionuclides on the river fauna and mud has also been investigated. The results obtained have revealed no reconcentration phenomena. (tr-auth)

16092 RECIPIENT CAPACITY OF TVAEREN, A BALTIC BAY. Agnedal, P. O.; Bergstroem, S. O. W. (AB Atomenergi, Studsvik, Sweden). pp 753-67 of STI-PUB-126.

The capacity of Tvaeren Bay to accommodate radioactive waste from research reactors and a waste disposal plant has been investigated for the purpose of changing Swedish regulations on waste disposal. The chemistry and biology of the Baltic water and the flora and fauna of the area are described. The routes by which the liquid waste activity may be transported back to humans are discussed. The research indicates that the disposal regulations should be changed. (L.C.L.)

16093 STUDY OF THE LA HAGUE MARINE SITE IN RELATION TO DISPOSAL OF RADIOACTIVE EFFLUENTS. Avargues, M.; Jammet, H. P. (CEA, Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 787-96 of STI-PUB-126. (In French).

The problems of radioactive effluent disposal into the sea have been investigated prior to the operation of the plant at the Hague for processing irradiated uranium rods. Research was conducted on the various parameters governing the establishment of permissible levels of disposal, such as analysis of general marine hydrography and ocean current data, specific hydrography of the region, ecology of the disposal zone, and the socio-economic habits and diets of the local population. The results of these investigations make possible an estimate of the approximate amount of radioactivity which may be discharged into the sea without causing a hazard to humans. The monitoring system for actual disposal operation was specified and will be used to check the findings of these preliminary studies. (L.C.L.)

16094 RADIOACTIVE WASTE DISPOSAL THROUGH MELTING INTO BASALT. Saidl, Yaroslav; Ralkova, Yarmila (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). At. Energ. (USSR), 21: 285-8(Oct. 1966). (In Russian).

It is shown that molten basalt is suitable for storing high specific activity radioactive wastes. Recrystallization of vitreous phases of molten basalt improved its mechanical and chemical properties and stability. Diffusion coefficients of molten basalt vary from 10^{-15} to 10^{-17} cm^2/sec at 30 to 70°C temperature. (tr-auth)

16095 RADIOACTIVE EQUILIBRIUM TIME. Goldsmith, William A.; Middlebrooks, Eddie J. (Mississippi State Univ., State College). J. Sanit. Eng. Div., Amer. Soc. Civil Eng., 92: 85-93(Dec. 1966).

Low concentrations of radioactive materials are continuously being discharged into natural water courses either directly or through seepage pits. These water courses must be monitored to assure public safety. Some of the radioisotopes considered as the greatest health hazards, e.g., ^{90}Sr, yield radioactive daughters. Aquatic organisms and silt deposits are known to selectively concentrate certain radioisotopes. For example, if a particular sediment which concentrates ^{90}Sr is to be counted, it is desirable that the ^{90}Sr be in equilibrium with its daughter ^{90}Y for an accurate count to be made. Since the initial equilibrium condition is unknown, it is important to determine how much time should be allowed for a sample to obtain equilibrium. A quick, dependable answer was sought. Beginning with the basic parameters, a series of equations for equilibrium time were obtained. The results of a computer program were plotted to facilitate the solution of these equations. Some practical examples are provided to illustrate the use of these calculations. These equations for equilibrium time for secular and transient equilibrium, with the accompanying graphical and tabular solutions, provide a quick and accurate answer when multiple calculations are required. (BBB)

16096 BENTONITE AS A PROTECTIVE COVER FOR BURIED RADIOACTIVE WASTE. Hawkins, R. H.; Horton, J. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 13: 287-92(Mar. 1967).

Wyoming bentonite clay prevented infiltration of rainwater into radioactive waste buried above the water table in a humid region. A lysimeter study showed that a 1-in.-thick bentonite layer was adequate and that drying and cracking of the bentonite during prolonged drought could be prevented with 2 ft of soil cover. A large subsurface bentonite structure built in the field demonstrated the feasibility of applying a continuous bentonite layer over extensive vertical and horizontal areas. The test was evaluated by D_2O tracing of soil moisture both outside and under the bentonite structure. Structures must be maintained free of all plant growth since bentonite is easily penetrated by roots. (auth)

16097 DEPOSITION OF SUBMICRON-SIZE PARTICLES IN VENTILATION DUCTS. Davis, L. P. (Oak Ridge National Lab., Tenn.). pp 131-38 of Surface Contamination. New York, Pergamon Press, 1966.

A 54 $in.^2$ concrete ventilation duct 1000 ft long, used to vent several high-level radioactivity facilities to a fan below a main stack, was used to study the deposition behavior of particles of 0.001 μ to 1.0 μ with concentrations ranging from 1 to 1000 mg/m^3. An equation was developed that provides a plausible means of predicting decreases in concentration due to deposition. The predicted decrease in concentration for the concentration investigated is negligible but the contamination on the duct walls can not be overlooked. (F.S.)

16098 SHIPPING CONTAINER FOR RADIOACTIVE MATERIALS (Engineering Materials). (Dow Chemical Co., Golden, Colo.). (CAPE-1546).

4 drawings.

The shipping container consists of an ICC metal drum 15 in. OD 17.5 in. high with an empty wt of 51 lb. A "2R" container is included in the drum but separated from it by cellulose wadding. The "2R" container is fabricated of steel tubing with a wall thickness of 0.250 to 0.275 in. The usable space must be 4.180 in. ID by 10 in. high. The container weighs 17 lb empty. The shipping container can be used to transport ^{241}Am, or ^{237}Np or ^{210}Po, ^{238}Pu, or ^{233}Pu metal, U metal and ^{235}U, ^{235}U and ^{239}Pu oxides. (For details see TID-4100, Suppl. 39). (F.S.)

Vacuum Engineering

Refer to abstract 16085.

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 16796, 17099, 17237, 17270, and 17318.

16099 (BNL–10863) GAMMA-RAY SPECTROSCOPY IN VAN DE GRAAFF RESEARCH. Alburger, David E. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT-30-2-GEN-16. 43p. (CONF-670103–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Low Energy Nuclear Physics, Dacca, East Pakistan.

A review is presented of the techniques used by the Brookhaven Van de Graaff group in the study of gamma rays from the excited states of light nuclei. The topics include the determination of multipolarities with a magnetic pair spectrometer, studies of gamma rays from short-lived activities, gamma-ray angular distributions and correlations, and various methods using lithium-drifted germanium detectors. The operating characteristics of the Brookhaven Van de Graaff accelerator are also described briefly. (auth)

16100 (BNL–11140) TRACK FOLLOWING REVISITED. Rabinowitz, George (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 11p. (CONF-670105–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Flying Spot Devices, Munich, Germany.

Experience with the track following program developed previously has suggested various ways in which the program might be improved. A new program was written which, while similar in over-all approach to the problem, differs in a number of significant respects. (auth)

16101 (BNL–50031) A DIFFERENTIAL LIQUID CHERENKOV COUNTER WITH CONTINUOUSLY VARIABLE VELOCITY RESPONSE. Leontic, B. A.; Teiger, J. (Brookhaven National Lab., Upton, N. Y.). Dec. 1966. Contract AT(30-2)-Gen-16. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A differential Cherenkov counter is described in which the velocity band to which the counter is sensitive is changed by altering the relative positions of the optical elements within the counter. The principle of its operation is briefly reviewed, and the design features and performance are discussed in detail. (L.B.S.)

16102 (CEA-R–3027) NOUVEAU COMPTEUR PROPORTIONNEL DESTINE A LA DETECTION IN VIVO DE TRACES DE PLUTONIUM DANS LES POUMONS. (New Proportional Counter for In Vivo Detection of Traces of Plutonium in the Lungs). Morucci, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 87p. (In French). Dep. mn.

Thesis. Submitted to Univ., Paris.

Development of a multi-wire proportional counter having a uniform response over 250 cm^2 due to corrections made for boundary effects, and having a low background per sq. cm. due to the use of two identical counters set in anti-coincidence in the same enclosure is described. (auth)

16103 (CLOR–60/D) PRZEDWZMACNIACZ LADUNKOWY I WZMACNIACZ IMPULSOWY DO DETEKTOROW POLPRZEWODNIKOWYCH. (The Charge-Sensitive Preamplifier and Linear Pulse Amplifier for Semiconductor Detectors). Glowacki, St. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 15p. (In Polish). Dep.

A charge sensitive preamplifier and linear pulse amplifier with resolution of 3.5 keV fwhm are described. The output signal level is 8 V for 200 keV of beta particle energy lost in a silicon detector. The expander of gain of 10 V/V in the amplifier is provided, owing to the fact that the accuracy of measurement is magnified. The amplifier is developed for direct driving of the pulse-to-time converter of a multichannel analyser. (auth)

16104 (CONF-660918) PROCEEDINGS OF THE 1966 INTERNATIONAL CONFERENCE ON INSTRUMENTATION FOR HIGH ENERGY PHYSICS HELD AT STANFORD, CALIFORNIA, SEPTEMBER 9–10, 1966. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). [1966]. Contract AT(04-3)-400. 689p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate abstracts are presented for 38 of the 113 papers presented. Twenty papers were previously included in NSA. For abstract numbers of these papers see CONF-660918 in the report number index. Fifty-five papers were in abstract or summary form only and were not abstracted for NSA. (B.G.D.)

For abstracts of individual papers see: 16105–16135, 16217, 17020, 17099, and 17204–17207.

16105 (CONF-660918–, pp 3-28) INFORMATION ABOUT THE COORDINATES AND THE ENERGY OF CHARGED PARTICLES FROM THE CURRENTS FLOWING IN SPARK CHAMBERS AND APPLICATIONS TO FAST DECISION-MAKING CHAMBERS. Charpak, G.; Favier, J.; Massonnet, L. (European Organization for Nuclear Research, Geneva (Switzerland)).

The measurement of coordinates by means of currents flowing in spark chambers is discussed. Topics include construction problems in obtaining orthogonal coordinates, calibration of the chamber, retrieval of information from the currents flowing in the chamber, response of the chamber, and repetition rates. Also discussed are the range chambers. (B.G.D.)

16106 (CONF-660918–, pp 39-40) SECOND GENERATION WIRE SPARK CHAMBER SYSTEM. Bleser, E.; Anderson, E.; Blieden, R.; Collins, G.; Fischer, J.; Menes, J.; Turkot, F. (Brookhaven National Lab., Upton, N. Y.); Edelstein, R.; Hien, N. C.; McMahon, T. (Carnegie Inst. of Tech., Pittsburgh, Pa.).

Operating experience is reported on an on-line wire spark chamber system as a momentum spectrometer to analyze inelastically scattered protons over a momentum range from 6 to 30 GeV/c. The design of a similar experiment is also reported for measuring inelastically scattered pions over a momentum range from 5 to 25 GeV/c. (B.G.D.)

16107 (CONF-660918–, pp 60-2) MATCHING PROBLEMS AND PARASITIC EFFECTS IN MAGNETOSTRICTIVE READOUT SYSTEMS. Gutmann, J.; Jauch, K.; Kunz, A.; Maeder, D.; Peter, M.; Von Felten, R. (Geneva Univ. (Switzerland)).

Short summaries are presented on various matching problems and parasitic effects in magnetostrictive readout systems. Topics include receiver development, wire excitation, torsion bar studies, parasitic waves, and longitudinal wave dispersion. (B.G.D.)

16108 (CONF-660918–, pp 63-7) SPARK CHAMBER SPECTROMETER WITH AUTOMATIC VIDICON READOUT. Hincks, E. P. (Carleton Univ., Ottawa (Ontario). National Research Council of Canada, Ottawa (Ontario); Anderson, H. L.; Evans, H. J.; Fukui, S.; Kessler, D.; Klare, K. A.; Lillberg, J. W.; Sherbrook, M. V. (Chicago Univ., Ill.); Martin, R. L. (Argonne National Lab., Ill.); Kalmus, P. I. P. (London Univ. (England). Queen Mary Coll.).

A spark chamber double-arm magnetic spectrometer with automatic vidicon readout system is described. It was set up in the external proton beam area of the Argonne ZGS to study missing mass spectra in p-p collisions at 12.3 GeV. (B.G.D.)

16109 (CONF-660918–, pp 71) SOME PROPERTIES OF THE TRACK-FOLLOWING SPARK CHAMBER. Caris, L.; Kuiper, B.; Williams, E. M. (European Organization for Nuclear Research, Geneva (Switzerland)).

A wide-gap spark chamber was operated in the plate-to-plate spark mode for a systematic study of its behavior as a function of chamber and pulse parameters. (B.G.D.)

16110 (CONF-660918–, pp 72-4) ON THE POSSIBILITY OF OBTAINING HIGHLY LOCALIZED BRIGHT TRACKS IN A HELIUM-FILLED STREAMER CHAMBER. Falomkin, I. V.; Kulyukin, M. M.; Pontecorvo, G. B.; Scherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems).

An investigation of a streamer chamber filled with helium at atmospheric pressure and operated under high overvoltages is reported. The high-voltage field was varied from 13 kV/cm to 25 kV/cm. Cylindrical glass chambers 100 mm high and 260 mm in diameter were used. Data on the discharge in pure helium and in helium with different admixtures are presented. (B.G.D.)

16111 (CONF-660918–, pp 79-81) METHOD FOR DETECTING MUONS STOPPING IN THE GAS FILLING AN ISOTROPIC DISCHARGE CHAMBER. Komarov, V. I.; Savchenko, O. V.; Fedyaev, N. S. ([Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems]).

A method for studying negative muon capture by nuclei and mesic atom processes by means of discharge track chambers is discussed. It is shown that it is necessary to trigger the chamber with mesons stopping in the gas of the chamber work volume. One of the solutions of this problem is to produce a meson beam with a half width of the range distribution close to the thickness of the gas layer in the chamber. (B.G.D.)

16112 (CONF-660918–, pp 82-4) STREAMER CHAMBER TRIGGERED BY A PROPORTIONAL COUNTER DESIGNED TO

REGISTER STOPPING MESONS. Falomkin, I. V.; Khazins, D. M.; Kulyukin, M. M.; Pontecorvo, G. B.; Scherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems).

A streamer chamber 140 mm high and 400 mm in diameter filled with helium with a 1% admixture of methane was made in order to register slow mesons stopping in the gas volume of the chamber. A multiwire proportional counter was constructed for selecting stopping slow mesons. The counter and chamber have a common gas volume. (B.G.D.)

16113 (CONF-660918–, pp 99) CHARACTERISTICS AND INITIAL OPERATION OF THE MICHIGAN–ARGONNE 40-INCH HEAVY LIQUID BUBBLE CHAMBER. Roe, B.; Sinclair, D.; Vander Velde, J. (Michigan Univ., Ann Arbor); Oswald, L. (Argonne National Lab., Ill.).

A brief summary of the characteristics and initial operation of the Michigan-Argonne 40-inch heavy liquid bubble chamber is presented. Topics include significant dimensions, magnets, and magnetic field mapping. (B.G.D.)

16114 (CONF-660918–, pp 100-1) THE LARGE HEAVY LIQUID BUBBLE CHAMBER "GARGAMELLE". Chayon, M.; Petiau, P. (Commissariat a l'Energie Atomique, Paris (France). Ecole Polytechnique, Paris (France). [Paris Univ.], Orsay (France). Faculte des Sciences).

The Gargamelle heavy liquid bubble chamber which is a 4.8 meter-long and 1.9 meter-diameter horizontal cylinder, with a useful volume of about 10 cubic meters is described. It will be operated at the CERN PS. (B.G.D.)

16115 (CONF-660918–, pp 102-3) TESTS WITH EXPERIMENTAL MODEL OF ANL 12-FOOT HYDROGEN BUBBLE CHAMBER. Bougon, M.; Froehlich, J.; Pewitt, E. G.; Simpson, J.; Stoy, S.; Tamosaitis, A.; Turner, L.; Vander Arend, P. C. (Argonne National Lab., Ill.).

The large size of the 12-foot hydrogen bubble chamber currently in engineering stages at ANL has presented a number of technical and engineering problems that need experimental exploration. A 2-foot diameter geometrically similar model was constructed to study the expansion, the thermal control and its optical effects, the sources and magnitudes of the dynamic heating, and other associated general bubble chamber problems. (B.G.D.)

16116 (CONF-660918–, pp 104-5) DESIGN STATUS OF ANL 12-FOOT HYDROGEN BUBBLE CHAMBER. (Argonne National Lab., Ill.).

The design status of ANL 12-foot hydrogen bubble chamber is briefly discussed. Topics include the cooling system, photographic system, illumination system, expansion system, and magnet system. (B.G.D.)

16117 (CONF-660918–, pp 106) THE ANL–MURA 30-INCH HYDROGEN BUBBLE CHAMBER. Mark, J. W.; Picha, R. E.; Voyvodic, L. (Argonne National Lab., Ill.); Peekna, A.; Walker, W. D. (Wisconsin Univ., Madison).

The design features of the ANL-MURA 30-inch hydrogen bubble chamber and its operating characteristics during the first 1.5-million pictures taken at the ZGS are described. (B.G.D.)

16118 (CONF-660918–, pp 107-21) SELECTED PROBLEMS AND SOLUTIONS IN THE DESIGN OF THE SLAC 40-INCH HYDROGEN BUBBLE CHAMBER. Ballam, J.; Blumberg, R.; Mark, J.; Skarpaas, K.; St. Lorant, S. (Stanford Linear Accelerator Center, Stanford Univ., Calif.).

Some design features of the SLAC 40-inch hydrogen bubble chamber are described. These features deal with the expansion bellows, piston design and the hydraulic expansion system, and the magnetic steel back plate. (B.G.D.)

16119 (CONF-660918–, pp 134-9) THE NORTHWESTERN UNIVERSITY 50-CM LIQUID HELIUM BUBBLE CHAMBER. Block, M. M.; Kenyon, I. R.; Keren, J.; Koetke, D.; Malhotra, P.; Walker, R. J.; Winzeler, H. (Northwestern Univ., Evanston, Ill.).

A brief description of the Northwestern University 50-cm liquid helium bubble chamber is presented which includes the magnet system, physical structure of the chamber, cooling system, expansion mechanism, photography, and optical system. The operation of the chamber is also briefly discussed. (B.G.D.)

16120 (CONF-660918–, pp 140-4) RELATIVISTIC RISE OF TRACK DENSITY IN BUBBLE CHAMBERS AND POLARIZATION EFFECT. Kotenko, L. P.; Merzon, G. I.; Chechin, V. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki).

The relativistic rise of the track density in propane bubble chambers was calculated and measured at different values of the critical energy necessary for bubble formation. (B.G.D.)

16121 (CONF-660918–, pp 145-8) BUBBLE DENSITY IN THE BROOKHAVEN 80-INCH HBC. Biswas, N. N.; Cason, N. M.; Derado, I.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D.; Clinton, E. M. (Notre Dame Univ., Ind.).

Measurements are reported in the Brookhaven 80-inch hydrogen bubble chamber which show that the chamber sensitivity C is a linear function of the expanded pressure $C = AP + B(T)$ where the slope $A = -2.6 \pm 0.8$ bubbles/cm-psia is independent of temperature, within errors, and the intercept $B(T) = 48.2\ T - 1170$ bubbles/cm. (B.G.D.)

16122 (CONF-660918–, pp 151-2) The "CRAB," A DEVICE FOR MEASURING BUBBLE DENSITY. Grether, D. F.; Keller, K.; Sard, R. D. (Illinois Univ., Urbana. Dept. of Physics).

A device was constructed and tested for measuring the mean gap length of a bubble chamber track, with a view to estimating the velocity of the particle which produced it. (B.G.D.)

16123 (CONF-660918–, pp 197-8) NEW APPROACH TO THE INSTRUMENTATION OF COUNTER EXPERIMENTS. Cresswell, J. V.; Wilde, P. (Rutherford High Energy Lab., Chilton (England)).

Two of the many characteristics of electronic equipment used with scintillation counters in high energy physics instrumentation are discussed. These are the use of fast or slow circuitry and the speed potential of circuitry. (B.G.D.)

16124 (CONF-660918–, pp 199-200) LARGE SOLID ANGLE GAS CHERENKOV COUNTER FOR ELECTRONS. Ashmore, A.; Davies, B. W.; Kalmus, P. I. P.; Miller, M. C.; Pritchard, T. W. (London Univ. (England). Queen Mary Coll.); Astbury, A.; Aylmer, G. (Rutherford High Energy Lab., Chilton (England); Blair, I. M. (Atomic Energy Research Establishment, Harwell (England)).

An atmospheric pressure Freon-12 ($C Cl_2F_2$) Cherenkov counter, which was built to detect electrons from the beta decay of sigma minus particles, is described. (B.G.D.)

16125 (CONF-660918–, pp 205-6) GAS CHERENKOV COUNTER WITH OPTIMIZED LIGHT COLLECTING EFFICIENCY. Hinterberger, H.; Winston, R. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies).

A large gas Cherenkov counter was designed and constructed to detect electrons from Λ^0 beta decay. (B.G.D.)

16126 (CONF-660918–, pp 215-19) MAGNETIC DETECTORS FOR ELECTRON–POSITRON COLLIDING BEAMS. O'Neill, G. K. (Stanford Univ., Calif. High-Energy Physics Lab.).

A review of spark chambers of several kinds shows that conventional, wide-gap, and streamer chambers would all be usable for a large-solid-angle magnetic detector for use at a storage ring, but that each of these chambers has rather serious disadvantages. It is therefore suggested that moderately wide-gap (5–10 cm) chambers with transparent plates made of wires be studied to find whether they would be practical for this application. A detector design was developed with the desirable features: no topological linkage of the storage-ring vacuum chamber, no field or gradient at the orbit, large solid angle and resolution uniform in polar angle, and direct single-camera photography without field lenses or mirrors. The resolution requirements for a detector to be used at the Italian National storage-ring facility Adone are also listed. (auth)

16127 (CONF-660918–, pp 264-5) THE ARGONNE NATIONAL LABORATORY–CARNEGIE INSTITUTE OF TECHNOLOGY 25-cm BUBBLE CHAMBER–SUPERCONDUCTING MAGNET SYSTEM. Derrick, M.; Fields, T.; Hyman, L.; Loken, J.; Martin, K.; Pewitt, E. (Argonne National Lab., Ill.); Fetkovich, J.; McKenzie, J. (Carnegie Inst. of Tech., Pittsburgh, Pa.).

A bubble chamber which was first to use a superconducting magnet is described. The chamber and magnet were operated at the ZGS in a low momentum separated K^- beam. (B.G.D.)

16128 (CONF-660918–, pp 266-7) PULSED FIELD BUBBLE CHAMBER OPERATION UP TO 225 KG AND PRELIMINARY FILM EVALUATION. Bergmann, W. H. (Max-Planck-Institut fuer Physik, Munich (West Germany)).

The operation of a pulsed field bubble chamber at 225 kG obtaining high quality tracks of 1.8 GeV/c protons with a flash delay (bubble growth time) of only 25 μsec is discussed. (B.G.D.)

16129 (CONF-660918–, pp 299-311) PEPR. Pless, Irwin A. (Massachusetts Inst. of Tech., Cambridge).

PEPR, a system for analysis of bubble chamber film, is discussed. The PEPR system consists of the PDP-1 computer, the controller, the scan table, precision scope and photomultiplier, and the track detector. (B.G.D.)

16130 (CONF-660918–, pp 312-26) SATR: AN AUTOMATIC SCANNING AND MEASURING MACHINE. Thompson, Murray A. (Wisconsin Univ., Madison).

The design and expected performance of a new type of automatic bubble chamber film analyzing machine are briefly discussed. (B.G.D.)

16131 (CONF-660918–, pp 336-7) IMAGE PLANE DIGITIZERS AT BROOKHAVEN NATIONAL LABORATORY. Palmer, Robert B. (Brookhaven National Lab., Upton, N. Y.).

The performance of four image plane measuring machines is described along with an improved design which is now working as a prototype and hopefully will have an accuracy comparable with Frankenstein-type machines. (B.G.D.)

16132 (CONF-660918–, pp 338-54) KONRAD: A REAL-TIME SPACE RECONSTRUCTION AND KINEMATIC INTERPRETATION OF BUBBLE CHAMBER EVENTS FROM 10 IMAGE PLANE DIGITIZERS CONTROLLED BY A PDP-7 COMPUTER. Davey, Peter G.; Mokry, Premysl; Schneider, Hermann; Stroebele, Herbert (Heidelberg Univ. (West Germany). Institut fuer Hochenergiephysik).

An automatic scanning and measuring system for rapid processing of bubble chamber film is described. The system was designed in order to measure rare leptonic and radiative decay modes of the charged Σ hyperons. (B.G.D.)

16133 (CONF-660918–, pp 389-408) CONVENTIONAL AND DIGITIZED SPARK CHAMBERS. Terwilliger, K. M. (Michigan Univ., Ann Arbor).

Some of the recent developments in conventional and digitized spark chambers are discussed. Topics include vidicon system, acoustic chambers, chambers with current division readout, wire chambers with magnetic core readout, wire chambers with delay line readout, possibility of liquid hydrogen targets inside spark chambers, and the use of spark chambers in spectrometer systems. (B.G.D.)

16134 (CONF-660918–, pp 415-27) RECENT PROGRESS ON PARTICLE DETECTOR TECHNIQUES. Alikhanyan, A. I. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki).

The shortcomings of the track spark chamber, in which the track corresponds to the true particle trajectory, are discussed. The search for new detection methods and methods of energy determination for particles at very high energies is also discussed. (B.G.D.)

16135 (CONF-660918–, pp 507-36) AUTOMATIC SCANNING: SPARK CHAMBER DEVELOPMENTS. Zanella, P. (European Organization for Nuclear Research, Geneva (Switzerland)).

The acquisition of spark chamber data by computers, either directly or via photographs and equipment, and the processing of this information into track data which form the input to geometric reconstruction and kinematic analysis programs are discussed. Particular emphasis is given to the software aspects of automatic scanning of photographic data. (B.G.D.)

16136 (DP–1080) ALPHA-COUNTING HAND AND FOOT MONITOR. Woodward, William J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1967. Contract AT(07-2)-1. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An instrument was developed for detection of alpha contamination on hands and feet. A practical alpha foot monitor was made possible by improvements in the aluminum-coated film used to cover the scintillation detectors. In the instrument, scintillation detectors are connected to counters made from standardized plug-in circuits developed at the Savannah River Laboratory. (auth)

16137 (INFN/TC–66/7) CIRCUIT FOR LABELLING AS A FURTHER AUTOMATIZATION IN MEASUREMENTS OF BUBBLE CHAMBER PHOTOGRAPHS. Focardi, S.; Minguzzi Ranzi, A.; Monari, L.; Serra, P. (Istituto Nazionale di Fisica Nucleare, Bologna (Italy)). June 14, 1966. 5p. Dep. mn.

A circuit is described for increasing the speed by which particle tracks photographs from bubble chambers could be measured. (B.G.D.)

16138 (JAERI–1113, pp 72-5) NEUTRON SPECTROSCOPY AT JAERI. Sakamoto, M. (In Japanese and English).

Brief descriptions are given of the pulse-type and triple-axis neutron spectrometers and of a diffractometer installed at JAERI for neutron scattering experiments. (S.F.L.)

16139 (JINR-P13–3123) POLUCHENIE KHOROSHO LOKALIZOVANNYKH SLEDOV VYSOKOI YARKOSTI V STRIMERNOI KAMERE S GELIEM. (Highly-Localized Bright Tracks in Helium-Filled Streamer Chamber). Kulyukin, M. M.; Pontekorvo, D. B.; Falomkin, I. V.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 20p. (In Russian). Dep. mn.

It is shown that by making use of admixtures of complicated hydrocarbons it is possible to obtain bright localized particle tracks in a streamer chamber with helium without preliminary shaping of the high-voltage pulse. (TSS)

16140 (JINR-E13–3141) FILMLESS SPARK CHAMBER SYSTEM FOR OPERATION WITH ON-LINE COMPUTER. Chuvilo, I. V.; Filipov, P. I.; Gavrilov, A. S.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 15p. Dep. mn.

A system of nine wire spark chambers having magnetostrictive readout, data acquisition electronics, used on-line with the computer BESM–3M, located at a 1 km distance from the experimental area, was designed and tested using a negative pion beam of the Dubna synchrophasotron. (auth)

16141 (KFK–453) A NOVEL METHOD FOR VERY HIGH RESOLUTION CROSS-SECTION MEASUREMENTS. Cierjacks, S.; Forti, P.; Kopsch, D.; Kropp, L.; Unseld, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 16p. (CONF-661014–42). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

A neutron time-of-flight spectrometer was put into operation using the Karlsruhe isochronous-cyclotron as a very intense pulsed neutron source. The very high recurrence frequency of the microstructure bunches from the cyclotron was reduced using a novel bunching-deflection system to avoid frame overlap problems while largely preserving the high average neutron intensity available from the internal beam. The performance data of the spectrometer are as follows: flight path 57 m, neutron pulse length 1 ± 0.3 ns full width at half maximum, integrated time averaged neutron flux ($0.2 \leq E_n \leq 50$ MeV) $\phi = (5 \pm 2) \cdot 10^4$ n.cm^{-2}s.$^{-1}$ at 57 m, while using a thick natural uranium target and deuterons of (45 ± 5) MeV. With the present flight path a maximum resolution of 0.02 ns/m was determined for the spectrometer. The time-of-flight apparatus and the first total cross-section measurements for some light and medium-weight nuclei in the energy region between 0.5 and 10 MeV are presented. (auth)

16142 (NYO–841-5) A REVIEW OF DETECTION SENSITIVITY FOR MONITORING OF ^{85}Kr. Smith, D. G.; Reist, P. C.; Silverman, L. (Harvard School of Public Health, Boston, Mass.). Feb. 1, 1967. Contract AT(30-1)-841. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The overall objective of this study was to develop a ^{85}Kr monitoring instrument capable of detecting a field concentration of 3×10^{-8} μCi/cc. A review is given of the major ^{85}Kr detection methods and the readily available sensitivities for each are tabulated. Several specially designed detectors containing an adsorbent for concentrating ^{85}Kr in the immediate vicinity of the detector are suggested and tentatively evaluated. Also discussed are possible mechanisms for concentrating krypton in a sample stream prior to measurement. Of all methods considered, this latter approach appears most promising for increasing the detection sensitivity for ^{85}Kr. (auth)

16143 (NYO–3246-9) STUDY OF AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS OBTAINED THROUGH SURFACE CONTOURING. Semiannual Report, July 1966–January 1967. Huth, Gerald C.; Locker, Robert J.; McKinney, Russell A.; Yerry, Donald F.; Cosmi, Frank M. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Contract AT(30-1)-3246. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study of avalanche type semiconductor radiation detectors obtained through surface contouring is presented. The study was undertaken in three sections: basic semiconductor research concerned with the optimization and evolution of the deep diffused avalanche detector structures, development of detector associated circuitry which takes maximum advantage of the fast avalanche amplification process, and a finite effort to apply avalanche detectors and instrumental concepts thus far developed to specific detection problems in other laboratories. (B.G.D.)

16144 (ORNL-TM–1765) NEW TECHNIQUE FOR REMOVING CHARGE FROM THE STORAGE CAPACITOR IN DIRECT CURRENT ANALOG-TO-PULSE-RATE CONVERTERS. Glass, F. M. (Oak Ridge National Lab., Tenn.). Feb. 23, 1967. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A new all-solid-state direct-current integrator integrates currents as low as 10^{-11} amp with an accuracy of 1%. Currents as low as 10^{-12} amp can be integrated with approximately the same accuracy when fast response is not a necessity. This integrator features solid-state current switches that have sufficient speed for single-range, recycling ionization detectors to cover four decades. These switches are complementary silicon planar transistors that operate in the inverted-mode with both their base-emitter and base-collector junctions reverse biased. The individual leakage currents in the quiescent state total about 10^{-13} amp. When matched complementary pairs are used, the algebraic sum of the leakage

current can be less than 10^{-14} amp. Recycling rates of 20 kHz are easily obtainable. (auth)

16145 (UCD-CNL-74) DIRECTIONAL CORRELATION ATTENUATION COEFFICIENTS WITH Ge DETECTORS. Carlson, George A. (California Univ., Davis. Crocker Nuclear Lab.). Jan. 23, 1967. Contract AT(11-1)-Gen-10. 32p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods are presented for finding accurate attenuation coefficients for a rectangular Ge detector. The coefficients and the corresponding ones for a cylindrical NaI detector are used in the Legendre polynomial series representing the directional correlation function for the finite solid angles subtended by the detectors. Examples are given for particular cases, and the computer program used in the calculation is included. (L.B.S.)

16146 (UCRL-17259) BUBBLE CHAMBER OPTICS. I. MODIFICATION OF ILLUMINATION SYSTEM FOR 82-INCH BUBBLE CHAMBER. II. ALIGNMENT OF CAMERA PORT WINDOWS. Norgren, Duane U. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 22, 1966. Contract W-7405-eng-48. 18p. (CONF-661042-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 51st Annual Meeting of the Optical Society of America, San Francisco, Calif.

The use of coat hanger retro-reflectors in converting a 72-inch to an 82-inch bubble chamber is discussed. A short method for determining alignment tolerances for camera port windows is also presented. (auth)

16147 (UJV-1712) MERENI TOKU RYCHLYCH NEUTRONU PRAHOVYM AKTIVACNIM DETEKTOREM. (Measurement of the Fast Neutron Flux by Threshold Activation Detectors). Rana, S. B. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1966. 28p. (In Czech). Dep. mn.

The measurement of fast neutron flux by threshold activation detectors, in a reactor core where the spectrum above about 0.5 MeV can be assumed to be a fission one, is discussed. A survey of threshold detectors and directions to choose a suitable detector are also given. The reaction ^{58}Ni (n,p) ^{58}Co was chosen for routine fast flux measurements in the VVR-S reactor; and the experimental results are shown graphically. (auth)

16148 (AD-644024) SEMICONDUCTOR NUCLEAR PARTICLE COUNTERS. Ryvkin, S. M.; Matveev, O. A.; Strokan, N. B. Translated from pp 1-40 of Poluprovodnikovye Schetchiki Yadernykh Chastits, Vypusk 10, Leningradskii Dom Nauchno-Tekhnicheskoi Propagandy, 1964. 55p. (FTD-MT-65-138). CFSTI $3.00 cy, $0.65 mn.

Descriptions of n-p type counters, their basic characteristics, the energy spectra of various types of radiation, the special features of electronic equipment, and the radiation stability of detectors are presented. The possibilities of using homogeneous semiconductors as nuclear particle counters are considered. (B.G.D.)

16149 (ORNL-tr-1511) CALCULATION OF ENERGY SPECTRA FROM CONTINUOUS PULSE HEIGHT SPECTRA. PART I. PRELIMINARY REMARKS. Futtermenger, W.; Hoff, H.; Sasse, S.; Wueneke, C. D. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1003. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

It is shown how pulse height spectra can be recalculated into energy spectra with the use of influence functions. The investigation refers to γ-spectra with an energy of up to 20 MeV, i.e., bremsstrahlung spectra, reactor spectra and scattering spectra of the most diverse sources. A NaI-scintillation crystal of 4'' × 5'' is used for which the influence functions are known. The fundamental mathematical formulations concerning the problems considered and instructions for their solution are compiled. The coefficients of the influence matrixes used in practice are developed from known reference spectra. It proves to be suitable to establish a favorable interval division for each of the different spectral forms. The accuracy attained for the energy spectra is reported. It is also shown how the recalculation pulse height spectra to the corresponding energy spectrum can be performed with the aid of a pulse height multichannel analyzer, with a teleprinter, and a few accessories without the use of a large digital computer. (auth)

16150 DIMINUTION OF SENSITIVE TIME OF SPARK CHAMBERS. Cork, Bruce; George, Daniel R.; Rangaswamy, T. N. (Univ. of California, Berkeley). Rev. Sci. Instrum., 38: 221-3 (Feb. 1967). (UCRL-16972).

The sensitive time of a thin gap spark chamber immersed in a magnetic field was measured. The magnetic field was normal to the electric field of the chamber, and various amounts of Freon 12 (CCl_2F_2) were used to decrease the sensitive time. A concentration of 100 ppm Freon 12 was sufficient to make the sensitive time less than ½ μsec, with an efficiency of greater than 70% for delays of less than 300 nsec. (auth)

16151 THERMOSTATING HIGH POWER COILS. Freedman, M. S.; Porter, F. T.; Wagner, F. Jr. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 38: 190-3(Feb. 1967).

Internal turbulent water cooling is used to limit electrical conductor peak temperature rise to 8°C, only 2°C above the outlet water temperature, and average temperature rise to 2°C, at a current density of 6750 A/cm^2, and a power transfer of 13 W/cm^2. The water is continuously purified to maintain a resistivity $\approx 10^7$ Ω-cm, to keep electrical leakage through 200 water junctions to less than 10^{-5} of the current in the conductors. A thermostating system using transient-limiting anticipator thermocouples keeps temperature excursions associated with large power steps (1–80 kW) to 1°C, a sevenfold improvement over the system without anticipators. (auth)

16152 EFFECT OF ANODE MATERIAL ON INTENSITY DEPENDENT SHIFTS IN PROPORTIONAL COUNTER PULSE HEIGHT DISTRIBUTIONS. Spielberg, N. (Philips Labs., Briarcliff Manor, N. Y.). Rev. Sci. Instrum., 38: 291(Feb. 1967).

The intensity dependent shifts in proportional counter pulse height distributions are compared for anode wire of 50 μ stainless steel, 50 μW, 25 μW, and 13 μW. (B.G.D.)

16153 PIONEER VI DETECTOR TO MEASURE DEGREE OF ANISOTROPY OF COSMIC RADIATION IN ENERGY RANGE 7.5 TO 90 MeV/NUCLEON. Bartley, W. C.; McCracken, K. G.; Rao, U. R. (Southwest Center for Advanced Studies, Dallas). Rev. Sci. Instrum., 38: 266-72(Feb. 1967).

An instrument designed to measure the degree of anisotropy of the cosmic radiation in the energy range 7.5–90 MeV/nucleon with an accuracy of better than one part in 10^4 is described. The instrument was flown on the interplanetary spacecraft Pioneer VI and VII, and the in-flight performance and, in particular, the in-flight calibration procedures are briefly reviewed. (auth)

16154 SURFACES USED IN HIGH RESOLUTION ELECTRON SPECTROMETRY. McGowan, J. William (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Rev. Sci. Instrum., 38: 285-7(Feb. 1967).

A method is described for obtaining surfaces with low reflectivity and secondary emission for electrons of 50 eV and below, and also surfaces which are easy to prepare and maintain at pressures approaching 10^{-7} Torr for beta spectroscopy. (B.G.D.)

16155 ERA OF THE SUPER BUBBLE CHAMBER ARRIVES. Derrick, M. (Argonne National Lab., Ill.). Nucleonics, 24: No. 12, 56-61; 67(Dec. 1966).

A review is given of existing bubble chambers and advances made in recent years in superconducting magnet technology. The demands for higher event rates and also for improved precision in track measurements have given rise to plans for a whole new generation of bubble chambers that will be an order of magnitude larger in size than any of the existing chambers. The large chamber projects at Saclay, Brookhaven, and Argonne are briefly reviewed. (L.B.S.)

16156 USE OF SPARK CHAMBERS FOR MEASURING POLARIZATION OF COSMIC MUONS AT 750 MeV/c. Landaud, G.; Patry, J. P.; Scherer, M. (Faculte des Sciences, Caen, France). Nucl. Phys., B1: 7-15(1967).

An experiment using a spark chamber gives the polarization of cosmic ray muons at 750 MeV/c. (auth)

16157 GEIGER COUNTER CURRENT-LIMITING CIRCUIT. Singer, Sidney (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Sci. Instrum., 38: 443-4(Mar. 1967). (LA-DC-8287).

A simple current-limiting circuit which can be used in connection with a Geiger-Mueller counter without affecting its operating characteristics is discussed. The technique involves placing a single transistor (connected in the emitter-follower configuration) in the ground return of the counter. (B.G.D.)

16158 CONSTRUCTION OF SPARK CHAMBERS WITH THIN FOIL PLATES. Earles, D.; Li, T. C. (Northeastern Univ., Boston). Rev. Sci. Instrum., 38: 447(Mar. 1967).

The construction and testing of spark chambers having aluminum foil plates as thin as 4.3μ to serve as a combination target-detector with low interaction cross section are discussed. After sparking 200,000 times on cosmic ray tracks, the spark chamber suffered only slight damage to the foils and no measured decrease in efficiency. (B.G.D.)

16159 VELOCITY DETERMINATION IN BUBBLE CHAMBERS. Barkas, Walter H. (Univ. of California, Riverside). Contract AT(11-1)-34. Rev. Sci. Instrum., 38: 425-7(Mar. 1967). (UCR-34P107-36).

The kind of information that can be obtained from a bubble chamber track is analyzed and the statistical reliability of each parameter is given. Practical matters entering into the measurements are discussed. (auth)

16160 NOTES ON HIGH VOLTAGE THYRATRON PULSER AND ON FILLING GAS FOR NEON TUBE HODOSCOPE CHAMBER. Bandyopadhyay, B. K.; Bhattacharya, Subhra (Presidency Coll., Calcutta). Indian J. Phys., 40: 487-8(Aug. 1966).

The filling gas and thyratron pulses used in the successful operation of neon tube hodoscope chambers developed by Bandyopadhyay et al. (1966) are discussed. (B.G.D.)

16161 DETECTION OF SINGLE PHOTO-ELECTRONS IN PULSE RADIATION DETECTORS. Campion, P. J.; Murray, D. K. (National Physical Lab., Teddington, Eng.). Int. J. Appl. Radiat. Isotop., 18: 203-4(Mar. 1967).

In studying the behaviour of radiation detectors it is of interest to examine their response to single primary electrons. A convenient way to generate such electrons is by means of the photoelectric effect, using suitable optical radiation. Since the intensity of such radiation and/or the efficiency of the photoelectric conversion process are rarely known, the question arises as to whether an instrument is in fact detecting single photo-electrons or multiple electrons generated within the appropriate time constant of the detector-amplifier system. It was established that a proportional counter can detect single electrons by comparing the mean pulse height with heights due to x rays of known energy. A rather simpler technique employing a system of metal filters, applicable to all pulse radiation detectors, is described. (UK)

16162 LOW-LEVEL BETA-SPECTROSCOPY OF SOLID SAMPLES BY MEANS OF A COINCIDENCE-TYPE SCINTILLATION SPECTROMETER COMBINED WITH A LOGARITHMIC AMPLIFIER. Tanaka, E.; Itoh, S.; Maruyama, T.; Kawamura, S.; Hiramoto, T. (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Appl. Radiat. Isotop., 18: 161-75(Mar. 1967).

A method of low-level β-spectroscopy is described. The background rate is reduced to 0.16–0.25 cpm by means of coincidence counting between a scintillation counter and a GM tube, the latter being operated as a gate of the former. The pulse-height distribution is obtained in a logarithmic energy scale, and the maximum β-energy can be determined by the linear extrapolation of the spectrum. The minimum detectable amount of activity of a known nuclide, defined as the activity equivalent to three times the standard deviation of the background counts, is about $1/\epsilon T^{1/2}$) dpm, where T is the counting time in minutes and ϵ the detection efficiency. For an unknown sample, the statistical standard error associated with the maximum energy determination is estimated to be of the order of $230/(\gamma T^{1/2})$ % when $\gamma \lesssim 1$ (γ is the sample-to-background ratio at the peak of the spectrum). The background characteristics, the shape of the logarithmic spectra, and several examples of the application are described. (auth)

16163 LOCUS-SENSITIVE PROPORTIONAL COUNTER. Grennberg, B. (Inst. of Physics, Uppsala). J. Sci. Instrum., 44: 203-6(Mar. 1967).

A proportional counter was constructed with a gas amplification factor varying continuously by several orders of magnitude over the tube length. Used as a detector for monochromatic radiation, the apparatus is designed to yield a pulse spectrum mapping the locus of the incoming radiation. Simultaneous detection of spectral regions can be accomplished by means of multichannel analysing techniques. The principle was conceived for small-angle scattering of x rays, but it may well be useful in many other fields. (auth)

16164 A LINEAR VELOCITY DRIVE FOR A MOESSBAUER SPECTROMETER. Cassell, K.; Jiggins, A. H. (Borough Polytechnic, London). J. Sci. Instrum., 44: 212-13(Mar. 1967).

A linear velocity drive is described, constructed from readily available components, which was found to produce a velocity continuously variable from 0.005 mm sec^{-1} to 2 mm sec^{-1} stabilized to within 1%. The accuracy of the velocity control is demonstrated by the results obtained for the measured linewidth of the 14.4 keV emission from a ^{57m}Fe Mössbauer source. (auth)

16165 PERFORMANCE STABILITY OF GOB-63 COUNTERS IN CURRENT-MODE CIRCUITS. Burek, Rudolf; Cierpisz, Stanislaw (Mining Inst., Katowice, Poland). Przegl. Elektron., 7: 596-7(Dec. 1966). (In Polish).

16166 SYSTEM OF COINCIDENCE CHERENKOV SPECTROMETERS WITH DATA ANALYSIS IN THE M-20 COMPUTER ANALYSIS. Aleksandrov, Yu. A.; Kutsenko, A. V.; Maikov, V. N.; Pavlovskaya, V. V. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 6, 50-4(Nov.-Dec. 1966). (In Russian).

A system of two total absorption Cherenkov spectrometers was designed for measuring the energy of coincidence γ quanta or electrons at 100 to 600 MeV. The energy and time resolution of the system is equal to ±21.5 to ±9.5% and 5 nsec, respectively. The electronic system is constructed on the basis of an AI-100 analyzer and takes into account computer analysis equivalent to a two-dimensional analyzer with 100 channels along the x and y coordinates. The total number of channels is $x \cdot y = 10{,}000$. (tr-auth)

16167 EFFECTS OF CAMERA CHARACTERISTICS ON THE ACCURATE REPRODUCTION OF PICTURES OF SPACE RECORDED EVENTS. Ivanov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 6, 66-9(Nov.-Dec. 1966). (In Russian).

A method is given for determining the performance of cameras and their influence on the accurate recording of space coordinates. It is shown that stereo cameras with identical performance simplified the reproducibility of the event geometry recorded in a bubble chamber. Camera selection criteria for accurate photographic performance are discussed. (tr-auth)

16168 EVALUATION OF VARIOUS PROPERTIES OF SCINTILLATORS FOR TRANSFORMATION OF GAMMA IMAGES INTO VISIBLE IMAGES. Zaidman, G. I.; Sviryakin, D. I.; Shpagin, A. P. (Tomsk Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 6, 90-3 (Nov.-Dec. 1966). (In Russian).

The feasibility of using scintillators for transformation of γ images formed by 30-MeV bremsstrahlung emission into visible images is discussed. The resolving power of various scintillators and of the diffusion zone of the images was estimated. The luminosity characteristics of NaI(Tl) and CsI(Tl) crystals of various thicknesses are evaluated. (tr-auth)

16169 SCINTILLATION COUNTER VESSEL. Alekseev, V. A.; Sulezhitskii, L. D. (Geological Inst., Moscow). Prib. Tekh. Eksp., No. 6, 188-9(Nov.-Dec. 1966). (In Russian).

The construction of a Teflon vessel used with a scintillation counter and with one or two photomultipliers is described. The vessel was used for determining small quantities of ^{14}C in natural specimens. (auth)

16170 POSSIBILITY OF ABSOLUTE CALIBRATION OF SEMICONDUCTOR DETECTORS FOR FISSION FRAGMENTS. Kashukeev, N. (Inst. of Physics, Bulgarian Academy of Sciences). Compt. Rend. Acad. Bulg. Sci., 19: 579-82(1966). (In Russian).

A method is suggested for absolute calibration of silicon detectors used for measuring the energy of fission fragments. The method can be utilized even under conditions when other methods fail, for instance, when the fissioning isotope standard is not available, when it is impossible to obtain heavy ions of certain energies, and when detectors have poorly developed plateaus or are working beyond the plane part characteristics. The method was tested with ^{252}Cf and compared with the data offered by H. W. Schmitt et al. (Phys. Rev., 137: B837(1965)). (R.V.J.)

16171 ANALYSIS OF GAMMA-RAY SPECTRA FROM SOILS AND PLANTS. I. COMPUTER PROGRAM WITH CORRECTION FOR GAIN-SHIFT AND SAMPLE BULK DENSITY. Elfield, Mark; Franklin, R. E. (Ohio Agricultural Research and Development Center, Wooster. Ohio State Univ., Columbus). Soil Sci. Soc. Amer., Proc., 31: 39-42(Jan.-Feb. 1967). (COO-414-1).

A computer program and counting techniques used in analyzing complex gamma spectra were developed. The program computes a standard spectrum for each radioisotope based on the bulk density of the sample and then corrects for differences in the energy equation of reference and sample spectra. A solution is then obtained by the method of least-squares. In addition to a numerical solution, the program provides logarithmic plots of the unknown spectrum, the solution, and the individual components. The approximate execution time is 10 to 15 seconds on an IBM 7094 computer. The program presently has a capacity of 16 standard spectra (512 channels each). This program has been applied successfully to the analysis of complex gamma spectra obtained from soils and plants. (auth)

16172 GENERAL PROPERTIES OF PEAKS IN THE SUM-COINCIDENCE SPECTRUM. Fairweather, I. L.; Gedcke, D. A. (Univ. of Ottawa). Nucl. Instrum. Methods, 49: 1-8(Mar. 1967).

General properties of γ-ray peaks in a sum-coincidence spectrum were derived assuming Gaussian-shaped photopeaks. New formulas for the half-width and detection efficiency are presented, and some experimental results discussed. Peak shift and asymmetry effects arising from an off-set sum-window are considered. The application of the theory to distinguish false pairs of peaks associated with Compton distributions is discussed. (auth)

16173 DETERMINATION OF THE CENTER OF GRAVITY OF PARTICLE SHOWERS BY MEANS OF THE DOUBLE-WEDGE METHOD. Pinkau, K.; Reppin, C.; Schoenfelder, V. (Univ.,

Kiel). Nucl. Instrum. Methods, 49: 13-21(Mar. 1967). (In German).

Using scintillators in the shape of a double-wedge, the center of gravity of a shower of particles (cascade axis, beam of particles) can be determined by the quotient of one signal to the sum of both. Measurements on electron showers are reported and discussed, in which the cascade axis could be determined to within about ±0.6 cm over a distance of 12 cm. This fairly large error is probably due to the fact that very important statistical processes (energy loss, photoelectron statistics) occur independently in each wedge of the double-wedge. In principle, it appears that much better core location can be achieved, for example, with proportional counters using high resistance wires, as has been shown by other authors for single particles, since then the fluctuations are common to both signal receivers. (auth)

16174 BETA-SPECTROGRAPH FOR IRRADIATION OF SEMICONDUCTORS IN A RANGE FROM 0.1 TO 1 keV. Kryachko, V. V.; Synorov, V. F. (Voronezh State Univ., USSR). Prib. Tekh. Eksp., No. 6, 61-3(Nov.-Dec. 1966). (In Russian).

A description is given of a beta-spectrograph designed for use in investigating the effect produced by electrons on semiconductors in the range from 0.1 to 1 keV. This spectrograph makes it possible to maintain an ultraconstant target temperature and to easily replace the target and the cathode. The design should satisfy the following conditions: light emitted by the cathode should not strike the target; relative error in the determination of the electron energy should not exceed 1–2%; and the target should have maximum protection against impurities resulting from dissociation of the cathode and against the condensation of the vapors of organic substances. The resolving power of the spectrograph was $D^{-1} = 0.9\%$. Maximum density of the beam current during operation with a tungsten cathode was approximately 10^{-6} amp/cm^2. Pulse rise time during pulsed irradiation was 0.2 μsec. The spectrograph was used to study changes of the surface energy states of germanium acted upon by electrons with an energy of 100–400 eV. The electrons generate a positive charge in the natural oxide film, coating the germanium surface. As a result the surface conductivity shifts from p- to n-type. The shape of the curve representing the dependence of the surface recombination S on the surface potential ϕ_s for germanium processed in H_2O_2 changes considerably during electron irradiation. In addition to the fundamental stable maximum S, a second induced maximum at $\phi_s < 0$ with a large amplitude value S appears as a result of irradiation. The amplitude of the induced maximum diminishes spontaneously to the initial level 10 to 15 min after irradiation. It is shown that the nature of the induced maximum S is associated with the recombination centers, whose effectiveness depends on the positive charge appearing in the oxide film. (ATD)

16175 REPRODUCTION OF PARTICLE KINEMATIC PARAMETERS BY THE TRACK-CHAMBER PICTURES CONSIDERING THE INHOMOGENEITY OF MAGNETIC FIELD, ENERGY LOSSES, AND COULOMB SCATTERING. Vishnevskii, V. F.; Ivanchenko, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 6, 64-6(Nov.-Dec. 1966). (In Russian).

A method is suggested for estimating the kinematic parameters of particles by measuring tracks in the chamber pictures taking into account magnetic field inhomogeneity, energy losses, and Coulomb scattering. (tr-auth)

16176 SPARK CHAMBER READOUTS DEVELOPED BY MAGNETOSTRICTION LINES. Gavrilov, A. S.; Golutvin, I. A.; Zanevskii, Yu. V.; Kirilov, S. S.; Kulakov, B. A.; Makarov, L. G.; Tsyganov, E. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 6, 69-75(Nov.-Dec. 1966). (In Russian).

A film-free apparatus for measuring coordinates and angular trajectories of charged particles based on magnetostriction line readouts in spark chamber is described. The instrument consists of two spark gaps with working electrode area of 500 × 500 mm^2, placed at a specified distance from each other. The distance may be adjusted for each specific case and requires a high angular precision. The readouts of the spark x and y coordinates in each gap indicated measuring precision of about 0.6 mm. The measurements of angular precision for 10-GeV/c particles with ~5 m base determined by multiple scattering in chamber walls and is equal to ~0.10 m rad. (tr-auth)

16177 RESOLVING TIME OF CHERENKOV COUNTER AND CHERENKOV SHOWER SPECTROMETER. Yakushin, V. V. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 6, 75-8 (Nov.-Dec. 1966). (In Russian).

The resolving time of FEM photomultiplier cathodes in a Cherenkov shower spectrometer was determined. The resolving time and efficiency of a spectrometer with a 10 radiation length thick TF-1 lead glass radiator for 500-MeV electrons were also evaluated. (B.G.D.)

16178 SPARK CHAMBER FOR RECORDING FISSION FRAGMENTS IN THE PRESENCE OF INTENSE ALPHA RADIATION. Gerasimov, V. F. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 6, 78-82(Nov.-Dec. 1966). (In Russian).

The efficiency of a multifilament spark chamber with plane cathodes for recording fission fragments in the presence of intense α background radiation was discussed. It is shown that the efficiency of chamber recording of fragments can reach 50% with low α particle background. (tr-auth)

16179 LUMINESCENCE OF SCINTILLATORS EXCITED BY PULSED X RADIATION. Pestov, S. V.; Lebedev, S. V. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 6, 88-9(Nov.-Dec. 1966). (In Russian).

Studies of the luminescence of various scintillators irradiated by pulsed x radiation showed that the law of luminescence is close to a hyperbolic function. (tr-auth)

16180 SHORT SCINTILLATION COLOR DETERMINATION BY USING TWO RECEIVERS WITH VARIOUS SPECTRAL PROPERTIES. Volkov, N. G.; Lyapidevskii, V. K. (Moscow Inst. of Engineering Physics). Prib. Tekh. Eksp., No. 6, 93-5(Nov.-Dec. 1966). (In Russian).

A concept of radiation color analogous to that of man's vision which would characterize the radiation and the system of radiation receivers is discussed. The concept is applied in the investigation of various scintillators following α and β particle passage through the crystal. It was shown that α and β particles produce different colors. (tr-auth)

16181 STUDIES OF EXPERIMENTAL EFFICIENCY OF SLOW NEUTRON DETECTORS WITH SPHERICAL MODERATORS. Keirim-Markus, I. B.; Uspenskii, L. N. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp., No. 6, 96-101(Nov.-Dec. 1966). (In Russian).

Efficiency functions for a slow neutron scintillation counter with spherical moderators with various dimensions operating as 5 eV to 17 MeV were obtained using a Van de Graaff accelerator and a pulsed reactor. Optimum dimensions of moderators were estimated for dosimeters and neutron radiometers. (tr-auth)

16182 IONIZATION CHAMBER FOR MEASURING ENERGY LOSSES OF BREMSSTRAHLUNG FROM ABSORPTION CALORIMETER. Kruglov, S. P.; Lopatin, I. V. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 6, 101-2(Nov.-Dec. 1966). (In Russian).

A description is given of a simple ionization chamber for measuring bremsstrahlung energy losses in a calorimeter. (R.V.J.)

16183 NEUTRON SPECTROMETER FOR INDENTIFICATION OF NUCLEAR LEVELS ACCORDING TO INCOMING NEUTRON ORBITAL MOMENTUM. Muradyan, G. V.; Adamchuk, Yu. V.; Moskalev, S. S. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 6, 43-50(Nov.-Dec. 1966). (In Russian).

Descriptions are given of a time-of-flight neutron spectrometer designed for identification of nuclear levels according to the orbital momentum of incoming neutrons. The selection of orbital momentum and optimum variation of crystal scintillation detectors are analyzed. The results of spectrometer measurements of the radiative capture of ^{107}Ag and ^{109}Ag isotopes and identification of ^{93}Nb energy levels at 400 to 550 eV are discussed. (tr-auth)

16184 LEAKAGE CURRENT AND NOISES IN SURFACE BARRIER PARTICLE DETECTORS. Masuda, M. (Tokyo Inst. of Tech.); Takeda, S.; Chisaka, H. Nucl. Instrum. Methods, 49: 77-85(Mar. 1967).

In order to obtain better semiconductor particle detectors, an investigation to understand the problems of surface effects was undertaken using planar type surface barrier detectors. The diode capacitance, the diode V-I characteristics and the noises were measured as a function of temperature in many detectors. The dominant reverse current was not correlated with the noises. The planar type detector was easy to perform and the surface phenomena were easy to understand. (auth)

16185 MEASUREMENT OF ELASTIC NEUTRONS BY ORGANIC SCINTILLATORS. Chatterjee, Arun.; Ghose, A. M. (Bose Inst., Calcutta). Nucl. Instrum. Methods, 49: 101-4 (Mar. 1967).

A method for the measurement of elastically scattered neutrons in the presence of inelastic ones was developed. The method consists in measuring the neutron intensity at two different biases of the recoil proton scintillation neutron counter. It was shown that these experimental results are sufficient to determine the elastic neutron intensity unambiguously. No additional data like differential elastic neutron cross sections etc., are required in this method.

The experimental test of this new procedure was carried out by measuring nonelastic cross sections of nuclei for 14.8 MeV neutrons. The experimental results indicate the consistency and the validity of the method. (auth)

16186 HIGH-ENERGY GAMMA-RAY DETECTOR WITH ANGULAR AND SPECTRAL RESOLUTION. Sadeh, D.; Kane, J. (Univ. of California, Los Angeles). Nucl. Instrum. Methods, 49: 105-8(Mar. 1967).

By using a bundle of two types of long and narrow scintillators, a relatively light and uncomplicated gamma-ray directional detector whose characteristics are suitable for astronomical use was developed. A prototype, having 9 crystals, was built and tested: it showed an angular resolution of 5° and an intrinsic efficiency of 18% for 200-MeV gamma rays. In addition to its directional properties, the detector can analyze the spectral characteristics of gamma-rays with an energy resolution of 40% at 50 MeV. Furthermore, improved models can easily be made by using more crystals. (auth)

16187 KNOTHOLE, A NEW SIDE-WELL GAMMA RAY DETECTOR. Lloyd, R. D.; Mays, C. W.; Atherton, D. R. (Univ. of Utah, Salt Lake City). Nucl. Instrum. Methods, 49: 109-13 (Mar. 1967). (TID-23430).

Knothole is a cylindrical crystal of NaI(Tl) 8.9 cm in dia. and 7.6 cm long. Piercing the curved side along a central diameter is a well 2.1 cm in dia. and 7.3 cm deep. Optically coupled to each of its two plane surfaces is a RCA 8054 photomultiplier tube. Resolution for the 662 keV gamma-ray of ^{137}Cs was measured to be 8.3%. The intrinsic peak efficiencies (counts in photo-peak per emitted gamma-ray) are about 61% at 88 keV, 47% at 513 keV, 37% at 662 keV, 19% at 1120 keV and 15% at 1460 keV. Limits of detection in pCi (3 standard deviations of background) using 60-min counting periods are: ^{137}Cs, 4; ^{131}I, 5; ^{226}Ra via ^{214}Bi, 11 (at 1760 keV); and ^{40}K, 58 (0.068 g K). (auth)

16188 DIRECT DETERMINATION OF SHORT-LIVED RADON DAUGHTER PRODUCTS ON AIR FILTERS BY LIQUID SCINTILLATION COUNTING USING A DELAYED-COINCIDENCE TECHNIQUE. Assaf, G.; Gat, J. R. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instrum. Methods, 49: 29-37(Mar. 1967).

The radioactivity on air-filters is measured by internal scintillation counting following immersion of the filter in a liquid scintillation solution. The resulting transparency of the filter ensures uniform counting efficiency of the nuclides, irrespective of their depth of penetration into the filter medium. The high counting efficiency for both α and β activity which is achieved makes it possible to measure the 1.6×10^{-4} sec ^{214}Bi–^{214}Po pair by delayed coincidence counting of their scintillation pulses; the relative amounts of ^{214}Pb and ^{214}Bi are then computed from the decay curve of this activity. Optimum counting conditions have been determined; the sensitivity obtained enables the detection of a 6% variation in the ratio of airborne ^{214}Pb and ^{214}Bi concentrations at ambient concentration levels of 0.1 dpm ^{214}Bi/l air. (auth)

16189 DEVELOPMENT OF AN ELECTRONIC SYSTEM FOR SCANNING OF TRACKS IN A NUCLEAR EMULSION. Barbier, J. P.; Bernheim, A.; Fayolle, J. C.; Morand, M. (Faculte des Sciences, Paris). Nucl. Instrum. Methods, 49: 38-44(Mar. 1967). (In French).

Relative to the automatic scanning of tracks in nuclear emulsion, a device is described which, starting from a television chain in a closed circuit, uses an electronic signal (video-frequency) to record the position of a track in the field of the camera. This solution is shown to work in the horizontal plan; the next step being the vertical plan. (auth)

16190 CHARGED PARTICLE TELESCOPE FOR USE IN THE MEASUREMENT OF THE COSMIC RAY ELECTRON SPECTRUM IN THE ENERGY RANGE 10 MeV TO 2 GeV. Webber, W.; Chotkowski, Ch. (Univ. of Minnesota, Minneapolis). Nucl. Instrum. Methods, 49: 45-54(Mar. 1967).

Recent observations near the top of the earth's atmosphere have indicated the presence of a component of extra-terrestrial electrons. The mating of a low pressure gas Cherenkov detector and a lead glass Cherenkov total energy spectrometer into a particle telescope that is suitable for measurements of this cosmic ray electron spectrum in the energy range 10 MeV–2 GeV near the top of the atmosphere is described. Various studies of the efficiency and calibration of the instrument were made and are discussed. In addition, tests of the response of this system to sea level cosmic ray muons and electrons and the measurement of the sea level electron spectrum are also reported. (auth)

16191 VOLTAGE-DEPENDENT-RESISTOR DYNODE CHAIN TO REDUCE THE VARIATION OF PHOTOMULTIPLIER GAIN WITH COUNTING RATE. Galloway, R. B.; Vass, D. G. (Univ. of Edinburgh). Nucl. Instrum. Methods, 49: 55-60(Mar. 1967).

A simple, compact dynode chain employing voltage-dependent-resistors to regulate the voltages applied to the dynodes of an EMI type 6262B photomultiplier is described. The use of this chain instead of a carbon resistor one enabled the range of counting rates over which a NaI (Tl) scintillation spectrometer could operate without excessive gain changes to be extended by a factor of 5. (auth)

16192 AUTOMATIC APPARATUS FOR α–γ ANGULAR CORRELATION MEASUREMENTS. Lewis, A. R.; Morris, J. P. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods, 49: 61-70(Mar. 1967).

Automatic equipment for the measurement of α–γ angular correlations is described. The circuitry for automatic operation is given in detail. Detectors used in the system are a coaxial Ge(Li) crystal for γ-rays and a silicon surface barrier detector for α particles. A simple method of determining the relative efficiency of the Ge(Li) detector as a function of energy is outlined. The electronics used for coincidence has a resolving time of ~5 nsec. (auth)

16193 CROSSED-WIRE SPARK CHAMBER WITH REMOTE CORE READOUT FROM BOTH ELECTRODES. Ehrlich, R. D.; Fryberger, D.; Jensen, D. A.; Nissim-Sabat, C.; Bounin, J. (Univ. of Chicago). Nucl. Instrum. Methods, 49: 176-8(Mar. 1967).

A system for remote core-readout of crossed-wire spark chambers, i.e., yielding both coordinates, is described. With this system, crossed-wire chambers are found to function as well as standard chambers. (auth)

16194 CHARGED PARTICLE SPECTROMETER FOR SPACE EXPERIMENTATION. Rinehart, M. C.; Winslow, R. G. (Philco Corp., Palo Alto, Calif.). Nucl. Instrum. Methods, 49: 125-44 (Mar. 1967).

The design and some test results for a near-earth satellite-borne solid state detector spectrometer intended to provide useful data on the directionality, spectral intensity, and time fluctuations of the natural and artificial trapped radiation belts, solar flare proton- and alpha emissions, and primary cosmic ray protons and alphas are discussed. The objectives of the intended experiment translate into requirements of instrument performance which are concerned with the identification of the particle types in the environment and the simultaneous measurement of the spectral intensity of each, with sufficient directional, time, and energy resolution to allow the data to be related to current models of trapped belt structure and flare proton propagation. The significant performance characteristics of the electronic modules under pulser excitation are described, and the response of the solid state detectors to electrons and protons of various energies is displayed. Particular attention is given to the particle mass and energy resolution achievable with the chosen technique over a wide energy range characteristic of space radiation. (auth)

16195 NaI(Tl) FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Rupaal, A. S. (Univ. of British Columbia, Vancouver). Nucl. Instrum. Methods, 49: 145-54(Mar. 1967).

The performance characteristics of an associated particle fast neutron time-of-flight spectrometer using a NaI(Tl) gamma ray spectrometer to give the zero time pulse is described. The spectrometer has an intrinsic electronic time resolution of less than 1×10^{-10} s and a time resolution of $(1.50 \pm 0.05) \times 10^{-9}$ s obtained by using 0.51 MeV annihilation radiation from a ^{22}Na source. The statistical limitations on the resolving time obtainable from the spectrometer are discussed. The versatility of the spectrometer is demonstrated by its ability to measure neutron angular distributions, n-γ angular correlations or coincidence gamma ray spectra. (auth)

16196 ELIMINATION OF SECOND ORDER EFFECTS IN TRIPLE-AXIS CRYSTAL SPECTROMETERS. Dolling, G.; Nieman, H. (Chalk River Nuclear Labs., Ont.). Nucl. Instrum. Methods, 49: 117-20(Mar. 1967).

One of the most serious problems encountered in the use of triple-axis crystal spectrometers for neutron inelastic scattering experiments is that of the order contamination inherent in the Bragg-reflected neutrons from the monochromator and analyzer crystals. An elegant solution to this problem is provided by the use of certain crystal reflecting planes for which the second and other higher order reflections are absent by symmetry, e.g., the (111) and (113) reflections from single crystals of germanium. High reflectivity germanium crystals having mosaic spreads in the range 0.3 to 0.5° were produced by the general method of Barrett, Mueller, and Heaton, and employed with considerable success in various crystal spectrometers at the NRX and NRU reactors at Chalk River. Details of the production method are

given, and a comparison is made between aluminum and germanium analyzer crystals in inelastic scattering experiments to determine the normal vibration frequencies of sodium nitrite and cobalt fluoride. (auth)

16197 RESPONSE OF A TISSUE-EQUIVALENT IONIZATION CHAMBER UNDER VACUUM. Trochev, T. (Bulgarian Academy of Sciences, Sofia). Acta Phys. Pol., 30: 1045-7(Dec. 1966). (In French).

The response of a tissue-equivalent ionization chamber under vacuum is studied as a function of the external electrode potential. Regions are found where the ionization current is proportional to the gamma intensity with which the chamber has been irradiated. (tr-auth)

16198 NUMBER OF EVENTS ACCORDING TO DATA FROM TWO OR THREE INDEPENDENT SCANNINGS. Diamandiev, V. A.; Markov, P. K.; Todorov, T. S. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 113-19(1966). (In Russian).

Formulas were found for the true number of events in the case of two or three independent scannings, assuming that this number is not fixed but changes around some mean value, following Poisson's law. It is assumed also that the probabilities for finding an event during the first and during the second scanning are different but constant during the scanning. The formulas obtained coincide with other results. A formula is suggested for the dispersion of the true number of events for a twofold scanning, which in the case where the probabilities of the first and second scannings are the same, coincides a previous result. A study was made of the difference in the true number of events obtained by the maximum likelihood method. (auth)

16199 MOESSBAUER SPECTROMETER USING AN ELECTROMECHANICAL TRANSDUCER IN CONJUNCTION WITH A MULTICHANNEL PULSE-HEIGHT ANALYZER. Katano, Rintaro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 44: 386-93 (Sept. 1966).

Some details of Moessbauer spectrometer using an electromechanical transducer as a constant acceleration driving device and a time-to-pulse-height converter in conjunction with a multichannel pulse-height analyzer are described. The motion of a moving part of the transducer on which a recoilless gamma-ray source is mounted is maintained in triangular velocity waveform by applying a motional feedback to the transducer. The linearity of the vibrating system for a triangular velocity waveform is achieved better than 0.8% during 80% of the half-period. (auth)

16200 PHOTOMETRIC IDENTIFICATION OF PARTICLES STOPPING IN BUBBLE CHAMBERS. Hourani, E.; Yuasa, T. (Institut de Physique Nucleaire, Orsay, France). Rev. Phys. Appl., Suppl. J. Phys., 1: 252-6(Sept. 1966). (In French).

The combination of a microdensitometer and a photometric method used to identify the particles stopping in a bubble chamber when their tracks are continuous on film, is described. The protons and the α-particles from the $^{12}C(p,p\alpha)^{8}Be$ reaction induced in a propane bubble chamber by a proton beam of the Orsay synchrocyclotron are studied. The identification is possible in the films when the incident protons have low apparent bubble density. (auth)

16201 SCINTILLATION CAMERA DESIGN AND METHODS OF MEASURING PERFORMANCE. Cradduck, Trevor David. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1966. 226p.

Thesis.

A stationary detector type of radioisotope scanner—a scintillation camera—was developed for the visualization of radioactive material in the human body. In order to assess the performance of this instrument and to study the effects of certain changes in the design of the camera, a simple set of criteria was developed. These criteria are measures of the spatial resolution, sensitivity and distortion. The spatial resolution is expressed in terms of the modulation transfer function derived from a simple line source of radioactive material. The sensitivity is expressed as counts per minute for a distributed source and this is combined with the modulation transfer function to give a figure of comparison. The distortion of a stationary detector scanner may be measured as "number" distortion which gives a differential linearity plot. In addition, these criteria are used to compare the performance of a scintillation camera with the performance of a moving detector scanner previously developed. Suggestions are made for future development and improvement in the performance of the scintillation camera. (auth)

16202 CATHODE RAY TUBE FILM SCANNER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1545).

61 drawings.

The cathode ray tube scanner is a program controlled automatic system for scanning 35 mm film in processing data from a spark chamber. The system provides a random access scan rather than digitized data of all the points on the film frame. To do this, the film reader is connected to one set of input-output channels of a Control Data 924 Computer. Program control of the spot allows flexibility in the method of scanning used. The scanner may be commanded into any one of three basic codes of operation, all under direct control of the computer's program. These are: response mode, in which the data intensity level is read out for each point addressed by the scan; interrupt mode which sends an interrupt signal to the computer only when a prescribed data level is found; and a film advance mode to release and move the film. Response and interrupt modes also provide subchoice of either a coarse or fine cathode ray tube (C.R.T.) spot for the scan. The equipment is divided into digital and analogue sections. Digital circuitry performs logic functions such as instruction sensing, decoding, and timing various analogue operations. (For details see TID-4100 Suppl. 39) (F.S.)

16203 NEUTRON MONITOR AND BURST DETECTOR. Glass, F. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,303,343. Feb. 7, 1967.

A system which combines a conventional count rate meter circuit for measuring gradual changes in neutron dose rate, and a circuit for detecting fast excursions in neutron dose rate is described. (AEC)

16204 GEIGER COUNTER DETECTOR FOR GAS CHROMATOGRAPHY. Williams, Frederick Wallace. University, Ala., Univ. of Alabama, 1966. 128p.

Thesis.

A Geiger counter was used as a gas chromatographic detector based on the principle of pulse attenuation. The pulse attenuation was recorded with a system which responds to pulse amplitude. There is a distinct advantage in using a detector in which a substantial part of the amplification results from an inherent property of the carrier gas. The gas, 1.3% butane–98.7% helium, was the most universal flow gas for Geiger counter counting work. A flow Geiger counter lends itself very well as a gas chromatographic detector. The chromatograms obtained using pure helium or 1.3% butane-98.7% helium are similar for the thermal conductivity detector. The retention times of compounds are different in the two carrier gases, but the retention volumes are the same. In a limited number of cases, there is an interaction with the carrier gas. The butane from the carrier gas is absorbed on the substrate and subsequently displaced by the material being analyzed. A negative peak appears just after the butane peak which indicates that the carrier gas equilibrium of 1.3% butane–98.7% helium has been upset. The detector is completely reproducible in its response to a constant volume injection of the same compound. Linear calibration curves are easily constructed for quantitative interpretation of the chromatograms. The chromatographic peaks derived from the Geiger counter when normalized to the thermal conductivity detector peaks show the same normal distribution. The characteristic peaks for the same compound in the two detectors may be very different as is shown by the relative response factors; this is due to the different mechanisms of response in the two detectors. There is little base line drift of the Geiger counter detector when the chromatographic column is going through a programmed temperature cycle. The base line of the Geiger counter shows average oscillations about a median line which is the result of statistical parameters of the system. The base line oscillation is not over 2%. The limit of detection of the Geiger counter depends on the foreign substance in the counter and the effective volume of the counter. The sensitivity for toluene is 9×10^{-10} mole, this concentration is not detected in a thermal conductivity detector. The pulse attenuation of a series of alcohols is the result of a parameter of the detector which can be related to the nature of the alcohols through the percentage of hydroxyl group character of the molecule. The pulse attenuation is characteristic of each alcohol that is introduced into the carrier gas stream. When a specific number of moles of each alcohol is chosen, and its corresponding pulse attenuation is plotted against the per cent of hydroxyl group in the alcohol, a straight line results from which an unknown alcohol can be characterized. Compounds other than alcohols, such as hydrogen, nitrogen and propane show unique attenuation data and can be characterized from previous calibration curves. (Dissertation Abstr.)

Radiation Dosimeters

Refer also to abstract 16464.

16205 (CLOR-56/D) THERMOLUMINESCENT DOSIMETER WITH MEMORY EFFECT. Roman, J.; Wolska, M.; Wysopolski,

J.; Urbanowicz, Z. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 10p. (CONF-660948-1). Dep.

From 2nd Health Physics Symposium, Pecs, Hungary.

A lithium fluoride thermoluminescent phosphor with two well separated glow maxima was developed. The thermoluminescent properties of the phosphor and the dosimeter operating characteristics are given. The dosimeter shows memory effect based on a multiple peak technique permitting for the accuracy rereading of the accumulated dose without loss of information. (auth)

16206 (CLOR-59/D) THERMOLUMINESCENT PHOSPHORS FOR RADIATION DOSIMETRY. Roman, J.; Wolska-Witerowa, M.; Urbanowicz, Z. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 23p. Dep.

Lithium fluoride and calcium fluoride phosphors with thermoluminescent properties were prepared from commercially available materials. The glow curves of the phosphors obtained by various methods are presented. Some preparation techniques having effect on phosphor thermoluminescent properties are considered. A simple thermoluminescent dosimetric system containing CaF_2–Mn phosphor, developed in this Laboratory was shown to be suitable to measure the gamma ray dose in milliroentgen range. (auth)

16207 (RISO-141) USE OF POLYVINYL-CHLORIDE FILM FOR ELECTRON BEAM DOSIMETRY. Ilic-Popovic, Jovanka (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1966. 18p. Dep. mn.

The suitability of a homopolymer type of PVC film (QCA-5960, 0.015" thick) as a high-dose electron dosimeter (1-5 Mrads) was investigated. Different heat treatments were applied in order to obtain a reasonable storage stability and an approximately linear relationship between optical density and dose over the dose range from 0.5 to 5 Mrads. The spectral range was 3900 to 5000 Å. The effect of the dose rate on the coloration of PVC was studied. (auth)

16208 (UCRL-50173(Suppl.1)) RADIOMETRIC CALORIMETRY: A REVIEW. SUPPLEMENT 1. Gunn, Stuart R. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 15, 1967. Contract W-7405-eng-48. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The literature in radiometric calorimetry, primarily of the last three years, is reviewed to supplement an earlier, more comprehensive review and discussion (S. R. Gunn, Nucl. Instr. Methods, 29: 1-24 (1964)). The principal topics are measurements of radionuclides, of photon and particle beam powers, of local absorbed dose, and of nuclear reactor radiations. Some proposed systems and calculations pertinent to particular calorimetric problems are included. (auth)

16209 DETERMINATION OF DOSE RATES 0 TO 3 mr/hr BY HALOGEN FILLED GM COUNTER TYPE DOB-60. Burek, Rudolf (Mining Inst., Katowice, Poland). Przegl. Elektron., 7: 600-1(Dec. 1966). (In Polish).

16210 DIGITAL GAIN STABILIZING CIRCUIT FOR A SEMICONDUCTOR GAMMA SPECTROMETER. Nekhai, A. P.; Marchenkov, V. V. (Inst. of Physics and Tech., Leningrad). Prib. Tekh. Eksp., No. 6, 55-60(Nov.-Dec. 1966). (In Russian).

A digital gain stabilizing circuit for a 1024-channel pulse-height analyzer is described. The pulse analyzer is used with lithium-drifted germanium detector as a gamma spectrometer. (B.G.D.)

16211 CHARACTERISTICS OF A FLUORIDE THERMOLUMINESCENT DOSIMETER WITH CHARGE-SENSITIVE AMPLIFIER. Nakajima, Toshiyuki; Hashizume, Tadashi (National Inst. of Radiological Sciences, Chiba, Japan). Oyo Butsuri, 35: 870-5 (Dec. 1966). (In Japanese).

The characteristics of a thermoluminescent dosimeter of fluorite crystals were investigated by a method in which a charge-sensitive amplifier was used. The reading system of this method is to integrate the intensity of emission glow under the required peaks. The data for zinc fluorite doped with manganese and for lithium fluorite were obtained as the basic data of thermoluminescence dosimetry covering the range of x-ray exposure dose from 10^{-1} to 10^{3} roentgen. (auth)

16212 EXTERNAL BACKGROUND EXPOSURE MEASUREMENTS OF USSR TOWNPEOPLE IN 1964-1965. Bochvar, I. A.; Moiseev, A. A.; Prosina, I. I.; Yakubik, V. V. At. Energ. (USSR), 22: 59-60(Jan. 1967). (In Russian).

Individual thermoluminescent aluminophosphate glass dosimeters were used to determine the annual external background dose to which the Soviet urban population is exposed, on the basis of a small sample. From June 1964 on, ten citizens were asked to wear the dosimeters for periods between 387 and 507 days in each of the selected 28 cities. The dose measurement error was less than ±20% with an additional error of ±4 mrad. The results revealed that the dose varied between 50 and 150 mrad/year. Seven high readings, up to 570 mrad, were not included because they are probably due to diagnostic x-ray exposures. The average dose of 90 mrad/year agrees with previous findings. (TTT)

16213 QUADRUPOLE PLATE-HOLDER FOR INDIVIDUAL DOSIMETRIC CONTROL. Mishev, I. T.; Hristova, M. G. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 73-9(1966). (In Russian).

A quadrupole plate holder of polysterol for individual dosimetric control has been constructed and studied. The plate holder consists of two independent halves fixed one into the other; it is attached to the working clothes without the use of such additional accessories as safety pins. With the aid of this plate holder it is possible to register mixed fields of gamma rays below and over 100 keV, of beta rays up to 1 MeV and of neutrons with thermal energy. (auth)

Radiometric Instruments

16214 TECHNIQUE FOR RAPID AND PRECISE POSITIONING OF NEUTRON DEPTH PROBES. MacGillivray, N. A.; Goldberg, Irving. Soil Sci. Soc. Amer., Proc., 30: 803-4(Nov.-Dec. 1966).

A device is described which replaces the standard cable clamp used for positioning of neutron depth probes. With the technique developed, positioning is accomplished by suspending the probe from brass stops affixed to the cable. Several years experience has demonstrated this technique to be entirely satisfactory, resulting in improvement in precision of probe positioning, as well as in a considerable saving of time. (auth)

16215 TRIAL CONSTRUCTION OF A METHANE METER EMPLOYING A RADIOISOTOPE. Matsukuma, Yoshifusa; Oba, Sigeyoshi (Resources Research Inst., Kamaguchi, Japan). Nippon Kogyo Kaishi, 82: 3104-5(Mar. 1966). (In Japanese).

The feasibility of constructing a methane meter employing an ionization current due to the passage of α-particles in the mine air was previously reported. An RI methane-meter capable of measuring the methane concentrations of 0 to 10%, and another with a high-gain dc amplifier for extending the scale range from 0 to 10% were constructed in trial. It consists of Ra as the source of α-particles, an ionization chamber for the measurement of a methane concentration and another ionization chamber for the compensation of the ambient condition, a vibration capacitance type electrometer (YEW, VM-16) a 100 μA. dc meter, an alarm, and out-put terminals for the automatic balancing recorder. The electrode voltage (200V) for the ionization chambers and the radioactivity (100 μCi) of the Ra source were selected so as to give satisfactory linearity, intensity and reproducibility of the response. Although the response of the methane meters is not affected by the variation of room temperature (±5°C) and of atmospheric pressure (±500 mmHg), the methane meter with the scale range of 0–10% methane concentration is slightly influenced by the variation of room temperature. The results given by the meters agreed with the results of the interference-type methane-meter. (NSA of Japan)

16216 RESULTS OF EXPERIMENTAL INVESTIGATIONS OF THE RD-15 INSTRUMENT FOR RADIOACTIVE MEASUREMENTS OF CURRENT VELOCITIES. Dimaksyan, A. M. Soviet Hydrol., No. 6, 548-63(1965).

Operational principles of an improved device for radioactive method of measurements of water current velocities are discussed. Results are reported of lab and field tests of the instrument, which was used to measure the speed of snowmelt runoff on slopes and low velocities of flow in open and ice-covered streams, and to measure discharge and movement of water in the ground. Consideration is also given to selection of the radioactive indicator and to its introduction into the medium under investigation. The method is one of introducing a small quantity of radioactive material in liquid form into the medium under investigation. The movement of the radioactive substance with the water of this medium is then determined with the apparatus described. The radioactive indicator may be introduced without producing a radiation level constituting a biologic hazard, since the amount introduced, although adequate for recording, is slight in relation to the total volume of the medium. The RD-15 radiometer, which is described, consists of a recording unit and two sensors. The instrument records γ radiation with an energy of more than 50 keV. The sensors may be submerged to a depth of 3 m or more in water and prolonged operation is possible if the readings are recorded on an automatic recording potentiometer. The circuitry of the RD-15 instrument is shown, as well as ratings of the elements. (BBB)

Miscellaneous Instruments and Components

Refer also to abstracts 16861 and 16884.

16217 (CONF-660918–, pp 157-70) RECENT PROGRESS IN THE DEVELOPMENT OF A MICROWAVE-GATED PHOTOMULTIPLIER: THE DCFEM. Murray, J. J. (California Univ., Berkeley. Lawrence Radiation Lab.).

A version of the dynamic crossed field electron multiplier (DCFEM) for particle detection via Cherenkov light was developed. The operation of the photomultiplier and its application to measurements of bunch structure of secondary beams at the Stanford Linear Accelerator are discussed. (B.G.D.)

16218 (INR-710/XVIII/P) KONSTRUKCJA I WYNIKI PROB KONDENSATORA IMPULSOWEGO 70 kV, 1.6 μF. (Construction and Test of the Impuls Capacitor 1.6 μF–70 kV). Nowikowski, J. (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 20p. (In Polish). Dep.

The construction of an impulse capacitor with a capacitance of 1.6 μF and a working voltage of 70 kV is described. The capacitor is the basic unit of a condenser bank used for the investigation of plasma injectors. (auth)

16219 (INR–763/III/E) TIMING SINGLE CHANNEL PULSE HEIGHT ANALYZER. Nadachowski, M. (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1966. 14p. Dep.

A transistorized single channel pulse height analyzer with a fixed delay of the output pulse is described. The delay may be adjusted from 0.5 to 1 μsec. The amplitude range of the analyzer is 200 mV–10 V. The block diagram, some circuit details and characteristics of the analyzer are given. (auth)

16220 (RT-EL–(66)-10) PROSPETTIVE DELL'ELETTRONICA ORGANICA. (Prospectiveness of Organic Electronics). Caserta, G.; Cervigni, T.; Fioroni, F.; Rispoli, B. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 15p. (In Italian). Dep. mn.

A review of the most important charge transfer phenomena observed in some organic materials is developed. The review emphasizes the possibility of using such organic materials as electronic functional devices, electronic circuit components and nuclear detectors. (tr-auth)

16221 (TID–23670) A LOW-NOISE, HIGH INPUT IMPEDANCE PULSE AMPLIFIER. Scientific Report No. 23. Bailey, W. H.; Blalock, T. V. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Dec. 27, 1966. Contract W-7405-eng-26. 112p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A simple two-stage voltage-sensitive amplifier with high input impedance was designed, constructed and evaluated for use as a wideband low-noise pulse preamplifier. The amplifier configuration is a common source field-effect transistor imput stage feeding a common-emitter bipolar transistor output stage. The two stages are enclosed by an overall series-feedback loop. The theoretical characteristics of the amplifier were determined by both digital computer and simplified equivalent circuit analyses and then verified by experimental measurements. The voltage transfer function and input impedance were determined as functions of frequency and transistor bias currents. A negative input resistance region was given special attention. The contributions of all important noise generators to the midband equivalent noise voltage (ENV) were obtained as functions of bias currents. The experimental amplifier had a voltage gain of 5, a bandwidth of 50 MHz. and an ENV of 5 nv./(Hz.)$^{1/2}$. (auth)

16222 (TID–23671) A WIDEBAND, LINEAR, TRANSISTORIZED CABLE DRIVER. Scientific Report No. 22. Barrett, J. G.; Blalock, T. V. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). Dec. 12, 1966. Contract W-7405-eng-26; Subcontract 2160. 89p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

A theoretical analysis and an experimental verification of a transistor, wideband, linear cable driver having a complementary emitter-follower output stage which is included in an overall series feedback loop are reported. The analysis is concerned with bandwidth, gain stability, drive capability, input impedance, and output impedance. The complementary emitter-follower output stage is analyzed for two quasi-linear modes of operation. The resistive and capacitive contributions of the first stage hybrid-pi parameters to the input impedance are found separately. The effects of an active, dc feedback loop on the stability of the quiescent operating levels, the low-frequency performance, and the output dc voltage are investigated. Experimental results are in excellent agreement with derived quantities. The driver is capable of driving ±2 volts linearly across 93 ohms with a 19 nanosecond 10 to 90 percent rise-time. The input capacitance does not exceed 4 pf. The input resistance becomes negative at frequencies exceeding 35 MHz. The output impedance is low and resistive for frequencies less than 500 KHz. For frequencies greater than 500 KHz, the output impedance becomes increasingly inductive. The rate of change of voltage gain with respect to ambient temperature is 20 parts per million per degree centigrade at room temperature (25°C). (auth)

16223 (UCRL-14723) A HIGH-VOLTAGE PULSE, REFLECTION-TYPE "FANOUT" ATTENUATOR WITH SUBNANOSECOND RESPONSE. Thomas, Robert J. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 10, 1966. Contract W-7405-eng-48. 41p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Subnanosecond response (as low as 0.1 nanosecond) was achieved for a high-voltage pulse attenuator based on the principle of traveling wave reflection at an abrupt reduction in impedance level at a specific boundary along a transmission line. It allows practically distortionless attenuation of the signal, independent of voltage level. The impedance mismatch in this particular design is effected by a fanout of multiple output cables fed from a single imput cable. The fanout junction, or header design, is critical in affecting rise-time response. This attenuator configuration is especially suited for use in a measurement system to attain high resolution of fast-changing, wide dynamic range, high voltage signals. (auth)

16224 (UJV–1621) GENERAL DYNAMIC SOLUTION OF A HIGH CURRENT POWER STABILIZER WITH SIMULTANEOUS CONTROL OF A POWER SOURCE AND A SERIES REGULATING ELEMENT. Schaferling, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1966. 15p.

The most important relations are derived which are essential for the design of a high current power stabilizer with simultaneous control of a power source and a series regulating element. The transfer functions of open loops are indicated in forms convenient for an easy drawing of amplitude and phase characteristics. The block diagrams indicated herein are suitable for combination of the simulator of the equipment on the analog computer. The work is completed with a detailed list of accessible publications treating various types of current stabilizers. (auth)

16225 (UJV–1675) APLIKACE TUNELOVYCH DIOD V RYCHLYCH OBVODECH ELEKTRONIKY PRO JADERNOU FYZIKU. (The Application of Tunnel Diodes in Fast Electronic Circuits for Nuclear Physics). Blaho, D. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 17p. (In Czech). Dep. mn.

Some of the most important applications of tunnel diodes in fast electronic circuits used for nuclear physics are reported. These are amplitude integral and differential discriminators, shaping circuits, binary and decade scalers, coincidence circuits, and analog-to-digital converters. (auth)

16226 (Y–1569) AUTOMATIC ELECTRODE LOADER AND POSITIONER FOR EMISSION SPECTROGRAPHS. Caylor, J. D. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 7, 1967. Contract W-7405-eng-26. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An apparatus has been built that automatically loads counter and crater spectrographic electrodes, positions both to a predetermined analytic gap, and automatically controls the analytic gap during burning. The maximum load of each device is forty samples. (auth)

16227 INVESTIGATION OF THE DEPENDENCE BETWEEN THE RADIATION OF SOURCES OF CONSTANT ACTION AND TEMPERATURE. Vitrichenko, E. A. Izv. Krym. Astrofiz. Observ., 35: 274-8(1966). (In Russian).

The intensity and spectral composition of radiation of three light sources of constant action and a Cherenkov radiation source, in dependence on temperature, were investigated in the temperature interval –30 to +40°C. (auth)

16228 PRECISION OF CONTINUOUS RELATIVE MEASUREMENTS OF THE SOLAR RADIO EMISSION FLUX. Yurovskii, Yu. F. Izv. Krym. Astrofiz. Observ., 34: 60-8(1965). (In Russian).

The stability of a modulating radiometer with variations of its parameters is discussed. A method is given for the computation of the optimal size of the antenna and the necessary precision of following of the source. The scheme of a radiometer with continuous control of the amplification coefficient and temperature of the compare channel is described. (auth)

16229 PHOTOMULTIPLIER TUBE PULSES INDUCED BY γ RAYS. Dressler, Kurt; Spitzer, Lyman Jr. (Princeton Univ., N. J.). Rev. Sci. Instrum., 38: 436-8(Mar. 1967).

A study is presented on the effects of gamma rays on the production of numerous pulses in different types of photomultiplier tubes. The investigation was restricted to end-on EMR tubes. (B.G.D.)

16230 DUAL RANGE SELF CALIBRATING VELOCITY SELECTOR. Grosser, Arthur E. (McGill Univ., Montreal). Rev. Sci. Instrum., 38: 257-9(Feb. 1967).

A slotted disk type velocity selector which transmits a velocity selected beam when rotating in either a clockwise (forward) or counterclockwise (reverse) sense was constructed and tested. The selector has two ranges: high velocity (1880 m/sec at 30,000 rpm) with low resolution (19.2%), and low velocity (940 m/sec at 30,000 rpm) with high resolution (7.2%). The calibration of the selector is performed without reference to any of the properties of the molecular beam used in the calibration procedure. (auth)

16231 DIGITAL-ANALOG MAGNETOMETER UTILIZING SUPERCONDUCTING SENSOR. Forgacs, R. L.; Warnick, A. (Ford Motor Co., Dearborn, Mich.). Rev. Sci. Instrum., 38: 214-20(Feb. 1967).

A magnetometer was developed which utilizes a superconducting quantum interference device (SQUID) as a sensor, and permits digital and analog measurements of magnetic fields. The digital mode permits measurement of large field changes with a constant accuracy of approximately $1/10$ the natural periodicity of a SQUID. (The natural period is typically 10^{-6}–10^{-3} G.) Thus, the precision of measurement of large field changes is high. The analog mode is advantageous for high precision measurement, of the order of 10^{-8} G, but for small field changes. Combined mode measurements permit the very high precision of the analog mode to be combined with the large range of the digital mode. The digital mode, which represents an improvement over the original lock-on magnetometer, utilizes two synchronous detectors to provide signals which uniquely determine the instantaneous magnetic bias of the SQUID. The synchronous detector outputs drive a novel logic circuit which produces appropriate add-subtract pulses to a digital counter, which reads out field changes in units equal to the periodicity of a SQUID. (auth)

16232 MULTICHANNEL ANALYZER SYSTEM FOR HIGH SENSITIVITY MASS SPECTROMETRY. White, J. W. (Physical Chemistry Lab., Oxford). Rev. Sci. Instrum., 38: 187-208(Feb. 1967).

A multichannel analyzer using time–amplitude conversion for time of flight mass spectrometry is described. This system extends the ultimate sensitivity of the Bendix mass spectrometer from about 10^{-8} mm to about 10^{-11} mm partial pressure of H_2 in the source, while still retaining whole spectrum presentation. It is equally applicable to negative and positive ion pulses, and so greatly improves the flexibility of the spectrometer. Examples of mass spectra from low partial pressures of gas are given showing the signal to noise improvements up to 10^3 obtained for a minute's operation. (auth)

16233 SINGLE-ELECTRON RESPONSE OF A POROUS KCl TRANSMISSION DYNODE AND APPLICATION OF POLYA STATISTICS TO PARTICLE COUNTING IN AN ELECTRON MULTIPLIER. Dietz, L. A.; Hanrahan, L. R.; Hance, A. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Rev. Sci. Instrum., 38: 176-83(Feb. 1967). (KAPL-P-3172).

The single electron statistics of a porous KCl transmission dynode are studied experimentally. Pulse amplification for subsequent analysis in a multichannel analyzer is obtained by coupling the output of the transmission dynode to a 14 stage electron multiplier. The observed pulse height distribution is quasiexponential. Single primary electrons, emitted thermionically from a hairpin filament and accelerated to 8–9 kV impact energy, produce stable secondary electron yields of 30–40 electrons at pulse counting rates up to 2×10^6 cps. In a second experiment, the KCl transmission dynode is preceded by an Al_2O_3 target surface, which is bombarded by single ions and produces a peaked secondary electron distribution from this surface. In this case, the anode pulse height distribution of the electron multiplier also is peaked, but has a relative variance greater than that expected from Poisson statistics. The two physical arrangements cover a wide range of shapes of pulse height distributions, and the resulting compound distributions are in good agreement with theoretical shapes calculated from a Polya statistical model, which includes Poisson and exponential distributions as limiting cases. (auth)

16234 INEXPENSIVE WEAK RANDOM LIGHT SOURCE FOR TIMING PHOTOMULTIPLIER CHANNELS. Burnham, J. B.; Packer, L. L. (United Aircraft Research Labs., East Hartford, Conn.). Rev. Sci. Instrum., 38: 288-9(Feb. 1967).

The use of a weak radioactive source and an appropriate scintillator for timing a pair of photomultiplier channels used in detecting fast coincidences is discussed as a simple and inexpensive method. (B.G.D.)

16235 MASS MARKER FOR THE AEI MASS SPECTROMETER MS2H. Tromp, F. M.; Wijnbergen, J. J. (Unilever Research Lab., Vlaardingen, Netherlands). J. Sci. Instrum., 44: 209-11 (Mar. 1967).

In order to simplify the calibration of mass spectra, a mass marker has been designed for the AEI mass spectrometer MS2H which, with slight modifications, can be applied to any other magnetically scanned spectrometer. During the scanning of the spectrometer, the apparatus operates the marker pen of the recorder so that calibration markings are registered during recording of the spectrum. The marker is based on accurate determination of the current through the deflection magnet which is used for the magnetic scanning in the spectrometer. The influence of the hysteresis effect is eliminated by automatic programming of the magnetic current before each measurement. When the marker is used with an AEI mass spectrometer MS2H, spectra can be calibrated at every fifth m/e in the range 60–535 m/e, provided the ion-accelerating voltage is 2000 v. The accuracy is to 0.3 m/e. (auth)

16236 FOUR-STAGE MASS SPECTROMETER OF LARGE RADIUS. White, F. A.; Forman, L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Rev. Sci. Instrum., 38: 355-9(Mar. 1967).

A research mass spectrometer was constructed comprising four analyzing elements; two electrostatic and two magnetic 90° lenses, each with a mean radius of curvature of 50.8 cm. The instrument can be programmed for the mass and energy resolution of both primary and secondary ion species, making the spectrometer an attractive tool for studies of sputtering, charge exchange, and dissociation phenomena. A high isotopic abundance sensitivity ($\sim 10^8/1$) was also achieved, a figure of merit that is important in nuclear measurements and special tracer applications. (auth)

16237 TWO DIRECTIONAL BEAM CONVERGENCE BY SECTOR SHAPED UNIFORM MAGNETIC FIELD. Ezoe, Hirohiko (Inst. of Physical and Chemical Research, Tokyo). Rev. Sci. Instrum., 38: 390-7(Mar. 1967).

In order to increase the ion transmission in a mass spectrometer, an ion optical system which renders the output ion beam from a magnet parallel to the median plane is proposed, and its general design formulas and processes are presented. The characteristics and the merits of the present system over the conventional two directional beam focusing arrangement are discussed and some numerical examples are given. (auth)

16238 NEW EXPERIMENTAL METHOD FOR PERTURBATION MEASUREMENTS IN CAVITY RESONATORS. Veyron, B.; Voisin, G. (Univ., Lyon). Rev. Sci. Instrum., 38: 410-14(Mar. 1967).

New experimental equipment is presented for field strength measurements in low Q cavity resonators by means of the perturbation method. The main part of this equipment is an admittance meter which enables us to perform both amplitude and direction measurements by an extremum method. (auth)

16239 RELATIVE NATURAL RADIOACTIVITY OF PHOTOMULTIPLIERS FEU-49. Sivintsev, Yu. V.; Kanareikin, V. A.; Serdyuk, L. N. At. Energ. (USSR), 22: 60-3(Jan. 1967). (In Russian).

The sensitivity of instruments used for the radiometric determination of very small amounts of radiation emitters is greatly reduced if materials containing naturally radioactive impurities are used for construction. In particular, the presence of ^{40}K in the NaI(Tl) crystals, the glass, and container material of photomultipliers affects strongly the background level of scintillation counters. For this reason, the level of radiation purity of the recently designed large-diameter FEU-49 photomultiplier, with a flat photocathode was determined. The measurements were carried out in a $2 \times 2 \times 2$ m steel chamber. A large NaI crystal was used to determine the γ background; regular and potassium-free glass was employed for the photomultiplier. The count rate at the 1.46 Mev photopeak of the γ quanta of ^{40}K served to establish the K concentration in the glass. The results indicated that the potassium content of the special glass was about ten times lower than that of ordinary glass. The 20-cm thick steel shield allowed to reduce the count rate to 6 to 8,000 pulses/hour for 1 kg of the scintillator. (TTT)

16240 PRELIMINARY DESIGN STUDY FOR A COMPUTER-INTERFACED MULTICHANNEL PULSE-HEIGHT ANALYZER FOR NUCLEAR DATA. Bevington, P. R. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 49: 9-12(Mar. 1967).

A circuit is described for a digital pulse-height analyzer constructed wholly from commercially available computer logic and pulse-handling modules. The design combines the reproducible

discrimination techniques of conventional analyzers for good differential linearity with a self-correcting successive approximation analog-to-digital converter for high speed and integral linearity. (auth)

16241 COMPARATIVE CALIBRATION OF IONIZATION MAGNETRON MANOMETER AND MAGNETIC ELECTRIC DISCHARGE MANOMETER UNDER SUPER HIGH VACUUM. Nichiporovich, G. A. Prib. Tekh. Eksp., No. 6, 150-4(Nov.-Dec. 1966). (In Russian).

An ionization magnetron manometer with a hot cathode capable of measuring pressures to 10^{-12} torr is described. Comparative calibrations of the inverse-magnetron manometer with a cold cathode and an ionization magnetron manometer with a hot cathode showed that the ion current dependence on the pressure in the inverse-magnetron manometer is retained at the pressure range from 10^{-12} to 10^{-4} torr. A linear dependence between the ion current and pressure at 10^{-12} to 10^{-6} torr was observed in ionization magnetron manometer. (tr-auth)

16242 STABILIZATION OF MULTICHANNEL RECORDING SYSTEMS (REVIEW). Efimchik, M. K.; Chernyavskii, A. F.; Shushkevich, S. S. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 6, 5-16(Nov.-Dec. 1966). (In Russian).

A brief description is given of various methods for parametric stabilization of multichannel recording systems and automatic adjustment to the standard signals. Possible stabilization of multichannel integrators used for enhancing sensitivity of nuclear and electron resonance spectrometers is discussed. (R.V.J.)

16243 DIGITALLY-CONTROLLED PRECISION PULSER. Greenblatt, J.; Kuchela, K. S.; Sherman, N. K. (McGill Univ., Montreal). Nucl. Instrum. Methods, 49: 86-8(Mar. 1967).

A precision pulser is described whose output pulse amplitude is proportional to the contents of the accumulator of a digital computer. The pulser, which has a 12-bit digital-to-analog converter, is assembled from commercially available circuit modules. Accuracy of linearity probably exceeds 0.1%. Under either program or manual control, the pulser can be used for on-line calibration of amplifier and pulse-height analyzer systems. (auth)

16244 TIME ANALYSIS SYSTEM FOR LIFETIME MEASUREMENTS. Clausen, K. D.; Nainan, T. D. (Nebraska Wesleyan Univ., Lincoln). Nucl. Instrum. Methods, 49: 22-8(Mar. 1967).

A time analysis system is described for measurement of lifetimes of nuclear states, including limiters for photomultiplier outputs, time-to-pulse height converter and fast coincidence system. The intrinsic resolving time for the time-to-pulse height converter is 40 psec and the resolving time of the whole system is about 1 nsec. (auth)

16245 FAST LINEAR AMPLIFIER. Manfredi, P. F.; Rimini, A. (Polytechnic of Milan). Nucl. Instrum. Methods, 49: 71-6 (Mar. 1967).

Two elementary amplifying stages for unipolar or bipolar pulses with rise time in the nanosecond range are presented. Starting from these basic configurations an amplifier with gain 100 was realized. The results of differential and integral linearity measurements, thermal stability and overload recovery time are given. The amplifier seems very accurate, simple and easy to reproduce. (auth)

16246 GATED PULSE CHARGE ANALYZER FOR HIGH-ENERGY BEAM PROFILE AND FLUX MEASUREMENTS. Lehraus, I.; Matthewson, R. (CERN, Geneva). Nucl. Instrum. Methods, 49: 93-100(Mar. 1967).

A fast gated pulse integrator and associated analog-to-digital converter was developed for measuring secondary beam profiles and total fluxes of high-energy particles from the pulsed accelerator with bunched beam and a few μs spill time. The circuit accepts repetitive signals from standard scintillation and Cherenkov detectors. The threshold charge sensitivity is about 70 pC. Linearity is better than ±5% over the input pulse amplitude range 0.7–30 V (negative pulse, 7 ns fwhm), the maximum over-all charge dynamic range is 1:500. The built-in gate width is variable in steps from 5 to 500 μs. (auth)

16247 CONNECTION OF AN ELECTRONIC DESK CALCULATOR TO A MULTICHANNEL ANALYZER FOR SPECTRUM INTEGRATION. Algranati, M. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instrum. Methods, 49: 170-2(Mar. 1967).

An interface between a standard electronic desk calculator and a multichannel pulse height analyzer was constructed to enable the calculator to be used for spectrum integration. (auth)

16248 SPECIAL PURPOSE DISCRIMINATOR FOR DELAYED NEUTRON SPECTRUM MEASUREMENTS. Mantakas, Ch.; Nicolitsas, A. J.; Chrysochoides, N. G. (Democritus Nuclear Research Center, Athens). Nucl. Instrum. Methods, 49: 161-4(Mar. 1967).

A specialized discriminator acting also as an anticoincidence circuit of one input is presented. Diagrams of the circuit and a description of the functioning of this discriminator are given. (auth)

16249 EQUIPMENT FOR ELECTROSPRAYING. Verdingh, V.; Lauer, K. F. (EURATOM, Geel, Belg.). Nucl. Instrum. Methods, 49: 179-80(Mar. 1967).

A new type of capillary, which combines a simple electrospraying capillary with a forced nitrogen nozzle, is described. The capillary was used to spray large surfaces with uranium and plutonium. (B.G.D.)

16250 ON-LINE COMPUTERS IN NUCLEAR RESEARCH. PART II. COMPUTER ANALYSIS OF PHOTOGRAPHIC IMAGES. Butler, J. W.; Butler, M. K. (Argonne National Lab., Ill.). Nucleonics, 25: No. 2, 44-51(Feb. 1967).

The automation of photographic image analysis in high-energy physics and biology is discussed. Topics include high-energy instrumentation such as spiral readers, Hough-Powell digitizers, precision encoders and pattern recognizers, Iliac III, and spark chamber analysis; and biological applications such as diagnostic indexes, chromosome images, and bone autoradiographs. (B.G.D.)

16251 ON-LINE COMPUTERS IN NUCLEAR RESEARCH. PART I. ON-LINE TECHNIQUES IN HARDWARE AND SOFTWARE. Jones, J. A. (Digital Equipment Corp., Maynard, Mass.). Nucleonics, 25: No. 1, 34-40; 78(Jan. 1967).

The use of on-line computers in nuclear research is discussed. Topics include data acquistion, data display, memory utilization, data channel transfers, data reduction, monitoring and control, and programming. (B.G.D.)

16252 USE OF THERMOCOUPLES FOR TEMPERATURE MEASUREMENT DURING LASER IRRADIATION. Nowak, W. B. (Northeastern Univ., Boston); Fine, S.; Klein, E.; Hergenrother, K.; Hansen, W. P. Life Sci., 3: 1475-81(Dec. 1964).

Since biological specimens are strongly affected by temperature changes of a few tens of degrees centigrade, accurate measurement of temperature distribution within in vitro and in vivo systems during and after laser irradiation is of importance. Large errors may occur with conventional use of thermocouples for measurement of the temperature response to laser radiation of biological systems and physical materials that partially transmit the radiation. Thermocouples positioned in the usual manner in the various tissue layers may yield gross errors due to direct absorption of incident and scattered radiation by the thermocouples. A calculation is made to indicate the possible large temperature error due to this effect. It is shown that the thermocouple, acting as a hot probe, can heat the surrounding material to a greater extent than would direct absorption of energy by the material. To evaluate errors which may arise in biological systems, experiments were conducted on physical systems to verify these considerations. Chromel-alumel thermocouples with junction-tip dia of ~0.002 in. and sheath diameters of 0.014 in. were exposed to unfocused radiation from a non-Q-switched ruby laser. The unshielded thermocouple, exposed in air perpendicular to a 12-J beam reached a peak temperature of 790°C, in agreement with calculations. However, erroneous measurements were obtained when the thermocouple was suspended in various media. (BBB)

16253 RAPID PNEUMATIC TRANSFER SYSTEM FOR IRRADIATION BY 14-MeV NEUTRONS. Martin, J.; Tousset, J. (Institut de Physique Nucleaire, Lyon). Rev. Phys. Appl., Suppl. J. Phys., 1: 243-6(Sept. 1966). (In French).

A rapid pneumatic transfer system for irradiation by 14 MeV neutrons is described. The system includes automatic ejection of the irradiated samples. The transfer time between the end of the irradiation and the start of counting is 1.5 second. The sample can be of any shape. (auth)

16254 BOUNDS ON THE INDEPENDENT ELEMENTS OF THE SCATTERING MATRIX FOR SOME MULTI-CHANNEL PROBLEMS. Bartram, Ralph Herbert. New York, New York Univ., 1960. 116p.

Thesis.

The Kato method, which is a general method for bounding the cotangent of the phase shift for a given angular momentum in a quantum mechanical central-potential scattering problem, is adapted to waveguides, including truly three-dimensional problems. The obstacle must be symmetric about a plane perpendicular to the waveguide axis with certain exceptions, only one mode should propagate and the system should be lossless. Analysis is then possible in terms of the real uncoupled phase shifts asso-

ciated with the even and odd standing waves respectively. The theory is applied to scattering by dielectric obstacles in rectangular waveguides. (TSS)

16255 FORMATION AND STUDY OF GASEOUS DOUBLY-CHARGED NEGATIVE IONS IN AN OMEGATRON MASS SPECTROMETER. Stuckey, Wayne Keith. Manhattan, Kan., Kansas State Univ., 1966. 121p.

Thesis.

The omegatron mass spectrometer has several features which distinguish it from other mass spectrometers. Examination of these features shows that conditions favorable for the formation of doubly charged negative ions exist in an omegatron ion source. The search for doubly charged negative ions first requires instrumental advances to extend the capabilities of the omegatron to the study of negative ions. Modifications are described which enable the selection of positive or negative ions in an omegatron mass spectrometer. The ions $F^=$, $Cl^=$, $Br^=$, $O^=$, and $CN^=$, with lifetimes of about 10^{-4} seconds, were observed in this study. A discussion of the credibility of doubly charged negative ions in the gas phase emphasizes the experimental evidence that gaseous doubly charged negative ions are being observed for the first time in any instrument. The paths of the ions in an omegatron mass spectrometer are distinctive to this instrument. Ions in an omegatron are not extracted from the ion source as in other mass spectrometers; instead, all but the ions being analyzed are retained very near to the electron beam by the applied rf field. That is, the ions not being detected have a long residence time in the ion source. Thus, a singly charged negative ion has opportunities to undergo reactions which do not occur in most mass spectrometer ion sources. The measurement of ionization efficiency curves and the dependence of the doubly charged negative ion intensity upon the square of the electron beam current indicate that atomic singly charged negative ions, formed on electron impact, react to form the doubly charged negative ions which possibly are stabilized in excited states. The singly charged negative ions could react with an electron, a molecule, or another ion. These possibilities are considered in view of the experimental evidence. Reactions with an electron does not seem probable. The data do not eliminate reaction with a molecule or reaction with an ion. The most logical explanation at the present is the reaction of a singly charged negative ion with a molecule followed by a second electron impact to form the doubly charged negative ion. The importance of the reaction of two singly charged negative ions cannot be determined because the residence time of the non-resonant ions in the omegatron ion source was not determined. (Dissertation Abstr.)

16256 TIME EXPANDER FOR MULTICHANNEL ANALYZER. Carroll, E. E. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,305,785. Feb. 21, 1967.

A time expander at the input of a multichannel analyzer is described having a short time train of successive input pulses divided into a plurality of equal time-spaced sequential groups of pulses which are superimposed on an expanded time scale with the groups at equal time-spaced points on the expanded time scale whereby the input to the analyzer is a sequence of groups of pulses permitting counting and storing of one group of pulses in a channel during the time period between groups of pulses. (AEC)

16257 VOLTAGE REGULATOR TUBE WITH INTEGRAL PLURAL SERIES DISCHARGE DEVICES. Yarmovsky, M. (to U. S. Atomic Energy Commission). U. S. Patent 3,303,381. Feb. 7, 1967.

A compact high voltage regulator tube is described. The tube consists of a cylindrical gas filled envelope containing a plurality of discharge devices in linear axial array. Each of said discharge devices includes a cup-shaped anode positioned coaxially of and within a cup-shaped cathode. (AEC)

Radiation Effects on Instruments and Instrument Components

16258 (N-66-36115) TRANSISTOR DESIGN EFFECTS ON RADIATION RESISTANCE. Honnold, V. R.; Thomas, G. D.; Berggren, C. C. (Hughes Aircraft Co., Fullerton, Calif.). Sept. 1966. Contract NAS1-4595. 73p. (NASA-CR-590). CFSTI $3.00 cy, $0.65 mn.

The problem of minimizing the degrading effect of high energy space radiation on a double diffused silicon planar transistor, and the radiation response of a majority carrier device (a multichannel field effect transistor intended for high frequency, high power application) were investigated. The following design variations were found to be significant for radiation resistance: small emitter area, heavy emitter doping, small base width, gold doped collector, and Czochralski material; it was demonstrated that these desirable variations could be incorporated into a radiation resistant prototype silicon planar transistor. The prototype transistor in tests with 31 MeV protons, and in comparison with three devices of other manufacture, showed the smallest degradation rate. Analytical expressions correlating the experimental results and furnishing the basis for further design studies are also reported. (STAR)

16259 TRANSIENT RADIATION EFFECT ON SEMICONDUCTOR CONTROLLED RECTIFIERS. Raburn, Wilford D. Albuquerque, N. Mex., Univ. of New Mexico, 1966. 100p.

Thesis.

In recent years there has been considerable effort devoted to describing the response of semiconductor devices to ionizing radiation. The primary effect of ionizing radiation is to create hole-electron pairs uniformly through the device. For this reason, the concept of charge control provides a powerful method for analyzing the transient response of semiconductor devices to ionizing radiation. The response of semiconductor controlled rectifiers is analyzed by considering the charge in the two base regions. An analytical mode was developed that predicts the response of the rectifiers under certain restricted conditions. The differential equations that were derived were more general than the linear model that a solution was obtained for. When the assumptions that were made concerning constant transport factors and saturated recombination currents are not satisfied, computer techniques may be used to solve the differential equations. A very simple relation, in terms of the device parameters, is obtained for the critical radiation dose required to trigger the device. The observed long delay time was explained with an effective time constant that is much longer than the life times of the base regions and by examining the voltage-current characteristic. (Dissertation Abstr.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 16410.

16260 (AD-639447) SUPPRESSION OF HEMOPOIETIC COLONY-FORMING UNITS IN MICE BY GRAFT-VERSUS-HOST REACTIONS. Davis, William E. Jr.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 22, 1966. 22p. (USNRDL-TR-1062). CFSTI $3.00 cy, $0.65 mn.

Attempts were made to characterize the time course of parental versus-F1 hybrid immunological reactions in sublethally irradiate mice. It was possible to reverse the lethal effect of the reaction by means of a second dose of x rays delivered up to 4 days after injection of the parental lymphoid cells. In contrast, mice irradiated 5 days or later succumbed to the disease. Non-irradiated host type colony-forming units in the spleens of mice undergoing the parental F1 hybrid disease were depleted at 5 days, and in the bone marrow by 7 days. It was not possible to reverse the lethal course of the disease with large doses of host type hematopoietic cells injected 3 to 6 days after injection of the parental cells. (auth)

16261 (EUR-3059.f) APPLICATIONS RADIOBIOLOGIQUES DE LA PHYSIOLOGIE CELLULAIRE. Rapport Annuel, 1964–1965. (Radiobiological Applications of Cellular Physiology. Annual Report, 1964–1965). (Brussels Univ. (Belgium)). May 18, 1966. 73p. (In French). Dep. mn.

Control exercised by the genetic substance (DNA) on the synthesis of specific proteins was the basic problem studied. A first series of studies related mainly to DNA: replication and structure of genetic material, problems raised by the presence of DNA in the cytoplasm, and fate of heterologous DNA's after introduction into the eggs of batrachians. Research on messenger RNA's, the metabolism of nuclear and cytoplasmic RNA's, the polyribosomes and monosomic ribosomes, and the transfer RNA's was also conducted. These studies were conducted with invertebrate, tissue culture, and vertebrate systems; biochemical, cytological, and radiobiological techniques were employed. Protein synthesis studies centered mainly on the synthesis of cytochromes, hemoglobin, histones, and antibodies. Immunological studies brought to light a new set of antibodies in the rabbit that was characterized as a new chain of type A. Parallel to this overall program, numerous specific studies were conducted on nucleic acid (DNA and RNA) metabolism and protein synthesis during oögenesis and embryogenesis of batrachians and echinoderms; production of cytasters in Batracien by treatment of eggs with heavy water; effects of various substances, such as, polysine, poly A, and levorphanol, on batrachian morphogenesis; effects of x-irradiation of batrachian eggs on embryonic development; photoperiodic rhythm in Acetabularia; fixation of tritiated actinomysin in isolated chloroplasts of Acetabularia; and autoradiography of DNA (labeled with thymidine-^{3}H) of Escherichia coli K12 and λ bacteriophage. Many techniques applicable to related fields were developed during these studies. (auth)

16262 (USNRDL-TR-1080) STUDIES ON THE TRANSFER OF MYELOMA PROTEIN SYNTHESIS WITH RNA ISOLATED FROM THE C_3H PLASMA CELL TUMOR (X5563). II. UPTAKE OF ISOTOPICALLY LABELED TUMOR RNA BY LYMPHOID CELLS. Chin, P. H.; Silverman, M. S. (Naval Radiological Defense Lab., San Francisco, Calif.). Oct. 11, 1966. 43p.

Studies were carried out to establish the conditions necessary for increasing quantitatively the uptake of exogenous RNA by incubating dissociated lymphoid cells of C_3H mice with ^{3}H- or ^{32}P-labeled RNA in vitro. The problem of adsorption of labeled RNA onto the surfaces of the cells was minimized by treatment of the cells with RNAse. The effects of RNA concentration, cell concentration and pretreatment of the lymphoid cells with protamine were investigated. In addition, attempts were made to identify the cell types involved. Uptake of exogenous RNA by normal lymphoid cells amounted to only 0.2% of the input RNA. Pretreatment of the cells with protamine sulfate, however, resulted in a twenty to thirty-fold enhancement in uptake. A further additional increase was observed when cells from mice injected with phytohemagglutinin were treated with the basic protein. Uptake by protamine-treated cells was very rapid and a nearly maximal amount was taken up after only 15 minutes of incubation. With a given RNA concentration, increasing the number of cells in the incubation mixture diminished the amount of RNA incorporated. Similarly, an inverse relationship was found between RNA concentration and uptake. Comparable amounts of RNA were taken up by lymph node and spleen cells and no difference was observed in the uptake of the different molecular species of RNA. Uptake by peritoneal cells, however, was marginal even after treatment with protamine. The cells primarily involved in the uptake of exogenous RNA appeared to be lymphoblasts. (auth)

16263 A STUDY OF THE EFFECTS OF LASER LIGHT ON NERVOUS TISSUE. Stellar, S. (New York Univ., N. Y.). pp 542-51 of Proc. Third Intern. Congr. Neurol. Surg., Aug. 23–7, 1965, Copenhagen. Amsterdam, Exerpta Medica Foundation, 1966.

The effect of ruby laser radiation was investigated by gross and microscopic examination of mouse and cat brain and by in vitro experiments. Tissue culture studies employing diploid cells derived from normal fetal lung tissue or HeLa cells derived from human uterine carcinoma showed striking effects. When the beam was intense, tissue culture cells were completely destroyed; areas in which cells were totally absent or badly damaged were produced. Since monolayers of cells are essentially transparent to light, cells may escape damage by not absorbing any energy. However, scattering of the beam by placing pigment on the sides of the glass container or within the cells themselves produced more consistent damage. Microscopic studies showed obvious signs of damage in the entire cell, particularly in the chromosomes. Examination of HeLa cells revealed the sharply demarcated lesion that could be produced in tissue monolayers. Laser beams did not provide a uniform area of damage due to the presence of hot spots within the beam itself. Lack of a uniform area was also due, in part, to opaque spots on the reflecting and transmitting mirrors of the ruby rod. (BBB)

16264 DEUTERIUM EXCHANGE ON DNA FOLLOWING ADSORPTION OF D_2O VAPOR. Killion, Philip J.; Reyerson, Lloyd H. (New England Inst. for Medical Research, Ridgefield, Conn.). J. Colloid Sci., 22: 582-7 (Dec. 1966).

A series of adsorption-desorption cycles of D_2O were made on DNA of salmon sperm in order to measure its total D exchange. Gravimetric measurements in a McBain tube apparatus showed the total exchange to be nearly twice the amount required for complete exchange of all labile hydrogens on the macromolecule. This amount would account for at least 3.3 molecules of tightly bound water per nucleotide pair and may in turn account for certain structural conformations in the molecule. This finding of tightly bound water was in agreement with other evidence that water is associated with DNA and its structure. An attempt to elucidate the mechanism of H-D exchange was made. Results showed that the presence of other gases, O_2 and N_2, along with D_2O or H_2O, affected both the rate of adsorption and the amount of exchange produced in a given adsorption-desorption cycle. (BBB)

16265 DIRECT DEMONSTRATION OF THE MONOMERIZATION OF THYMINE-CONTAINING DIMERS IN UV IRRADIATED DNA BY YEAST PHOTOREACTIVATING ENZYME AND LIGHT. Cook, John S. (Oak Ridge National Lab., Tenn.). Photochem. Photobiol., 6: 97-101 (Feb. 1967). (ORNL-P-2519).

It was shown that during in vitro photoreactivation of uv-irradiated DNA from Escherichia coli the disappearance of thymine-containing dimers was accompanied by a stoichiometric increase of monomeric thymine in the trichloroacetic acid insoluble material. This was done by uv-irradiating ^{3}H-thymine-labeled DNA, mixing it with unirradiated ^{14}C-thymine-labeled DNA, and exposing it to light in the presence of purified yeast photoreactivating enzyme. As the ^{3}H-thymine-containing cyclobutane dimers disappeared during the photoreactivation, there was a stoichiometric increase of monomeric ^{3}H-thymine as determined from the $^3H/^{14}C$ ratio in thymine. This was the first direct demonstration that thymine-containing dimers in uv-irradiated DNA are monomerized by yeast photoreactivating enzyme in the presence of light. (BBB)

16266 EFFECT OF DIETARY PHOSPHORUS SUPPLEMENTATION ON THE UPTAKE OF RADIOACTIVE STRONTIUM IN RATS. Harrison, G. E. (Medical Research Council, Harwell, Eng.); Howells, G. R.; Pollard, Jill; Kostial, Krista; Manitasevic, R. Brit. J. Nutr., 20: 561-9 (1966).

The effect of different forms of dietary P supplementation on the skeletal retention of radioactive Sr in rats on a basal diet in which the P was adequate for normal growth was studied. After ^{85}Sr and ^{45}Ca were fed for 10 days to weanling and adult rats receiving basal diets, all of which contained adequate Ca and P to support normal growth, the skeletal retention of the tracers was compared with

that in litter-mates receiving 7 different P compounds as dietary supplements so that the P intake was increased 2 to 3 times. In weanling rats a dietary supplement of KH_2PO_4 decreased the skeletal retention of ^{85}Sr by 30% without affecting the retention of ^{45}Ca. In adults on this supplement, the skeletal retention of ^{85}Sr was reduced by over 40% compared with controls on the same basal diet. When the supplement contained Ca as well as P, the reduction in skeletal retention of ^{85}Sr in young and adult rats was greater than when no Ca was present in the supplement. Thus, there was no evidence that supplements of P which also contained Ca induced any Ca deficiency in the rats. In rats receiving P supplements which also contained Ca, the ratio of the skeletal retention of ^{85}Sr, experimental to controls, was 0.45 for weanling rats and 0.52 in adults, 34 weeks old. These ratios were not significantly different for any of the 7 supplements used. From comparisons with previous experiments, it is concluded that supplementation with Ca plus P is more promising as a remedial measure for decreasing the uptake of radioactive Sr from the diet than supplementation with Ca alone. (BBB)

16267 THE DISTRIBUTION OF COBALT IN T. SUBTERRANEUM. Wilson, S. B. (Univ. of Adelaide); Hallsworth, E. G. Plant Soil, 23: 60-78(Aug. 1965).

The distribution of radiocobalt (^{60}Co) in plants of Trifolium subterraneum grown in soils with different levels of cobalt and nitrate nitrogen was measured. Clover nodules and to a lesser extent the roots were found to accumulate much more ^{60}Co than the leaves. The distribution of vitamin B_{12} type compounds and of ^{60}Co in the nodule was also determined following fractionation of the nodule components by high speed centrifugation. Most of the Co, whether present as vitamin B_{12} or as indicated by the measurement of ^{60}Co, was present in the supernatant and in the bacteroids. The distribution of ^{60}Co was similar in the nodules from both effective and noneffective strains. Quantities of vitamin B_{12} present in both bacteroids and supernatant were greatly increased, in relation to the fresh weight of the nodule tissue, when the supply of Co in the nutrient was raised. When ^{60}Co was incorporated into the plant, a proportion of the activity was found to be present as vitamin B_{12}, free from bacteroids, within 4 days of addition. After this time the supernatant still contained about 90% of the activity that entered. Of this, 40% was present as ionic Co, 19% as vitamin-B_{12}-like compounds, and the remainder as a compound, presently termed Factor N, so far unidentified. (BBB)

16268 EFFECT OF DEUTERIUM OXIDE ON THE SAPROPHYTIC CULTURE OF CLAVICEPS. I. NUTRITIONAL FACTORS. Mrtek, R. G.; Crespi, H. L.; Blake, M. I.; Katz, J. J. (Argonne National Lab., Ill.). J. Pharm. Sci., 54: 1450-3(Oct. 1965).

At high concentrations of D_2O the saprophytic growth of a clavin-producing strain of Claviceps purpurea (strain 47 A-Tyler) is highly dependent upon the carbon source. Minimal media containing only succinate as the carbon source supported growth at D_2O levels up to 90%, but growth was progressively inhibited by D_2O, and was extremely slow at the 80 to 90% level. Addition of glucose, however, led to good vegetative growth not only at 90% D_2O, but also at 99.6% D_2O. Alkaloid accumulation was also a function of both D concentration and the composition of the medium. Full deuteriation of the organism and successful maintenance of the culture was achieved on a medium containing fully deuteriated mixed monosaccharides (2%), deuteriosuccinic acid (0.5%), and traces of vitamins in a low phosphate salt medium. The fungus subcultured at 24-day intervals metabolized well, forming off-white surface pellicles. Deuterioglucose or fully deuteriated mixed monosaccharides supported growth to the same extent as protioglucose. When deuterio-sugars were used in combination with 0.5 to 7.0% protio- or deuteriosuccinic acid and vitamins in media above 98% D_2O, growth was obtained at all succinic acid concentrations, but growth was much better at lower concentrations of succinic acid. (BBB)

16269 X IRRADIATION OF REGENERATING LIVER IN ALBINO RATS. Mehrotra, R. M. L.; Agarwal, S. K.; Singh, M. P. (K.G. Medical Coll., Lucknow, India). Indian J. Med. Res., 54: 723-8(Aug. 1966).

In biochemical and histological studies following irradiation of regenerating liver, it was shown that x radiation doses of 3000 and 6000 R had little effect on the restoration of the liver mass or on the histological appearances of the liver. Biochemically, minor alterations in the irradiated liver were observed. In livers of rats sacrificed 24 hrs after 3000-R irradiation, two hours posthepatectomy showed swollen liver cells with fenestrated or vacuolated cytoplasm. Regenerative activity in the cells was minimal. At three days the histological changes in the irradiated animals consisted of fatty change in cells in the portal area, parenchymatous regenerative activity as indicated by hypertrophied or binucleate liver cells or cells with macronuclei, and focal aggregates of monocytes irregularly scattered in the parenchyma. There were no significant differences in liver glycogen, total lipids, water content, and RNA-phosphorus of irradiated and control animals at different periods. The total nitrogen and DNA-phosphorus levels in the liver of 3000 R irradiated animals were slightly less than in controls. There were no biochemical changes when 6000-R irradiation was performed 48 hr after partial hepatectomy. The explanation offered for this difference was the time interval between irradiation and hepatectomy. The concept that cells in the dividing stage are more susceptible to ionizing radiations did not appear to hold true for liver cells, since in these experiments radiation was delivered at periods of maximum cell multiplication. The resistance of liver to radiation was, therefore, attributed to the liver cell itself and was considered to be related to metabolic activities rather than to the resting or the dividing state of the cell. (BBB)

16270 THE ABSORPTION OF STRONTIUM BY PLANTS AS INFLUENCED BY CALCIUM IONS PRESENT IN CULTURE MEDIUM, USING RADIOACTIVE ^{89}Sr AS A TRACER. Chen, Chingching (National Taiwan Univ., China). Proc. Nat. Counc. Sci. Develop. Repub. China, No. 1, 153-62(Dec. 1965).

Absorption and translocation of strontium were studied in Chinese cabbage, variety Green Petiole. Radiostrontium was applied both to the roots and to the foliage of the plants which were grown in nutrient solutions with varying calcium concentrations (0, 50, 100, 200, and 400 ppM). Radioactivity was measured for various plant parts and autoradiograms were prepared. The absorption of ^{89}Sr by the roots was progressively increased as the calcium concentration in the culture medium was increased. Increased absorption continued up to 100 ppM calcium, after which a steady reduction of absorption followed as the calcium concentration in the culture medium was further increased. The same situation was found in foliar absorption of ^{89}Sr by Chinese cabbage. The translocation of root-absorbed ^{89}Sr was markedly affected by the calcium content of the culture medium. When the concentration of calcium in the nutrient solution was increased from 0 to 400 ppM, the translocation (% absorbed ^{89}Sr) was also increased from 11.99 to 78.35%. The translocation, if any, of foliar absorbed ^{89}Sr was very small. Strontium mobility in this plant was found to be low. Thus, translocation was not affected by calcium ions present in the culture medium. (BBB)

16271 POXVIRUS OFFICINALE INACTIVATED BY GAMMA RADIATION IMMUNOGENICITY OF THE ANTIGEN. Danes, L.; Hruskova, J.; Blazek, K. (Military Inst. of Hygiene, Epidemiology, and Microbiology, Prague). J. Hyg. Epidemiol. Microbiol. Immunol., (Prague), 10: 210-18(1966).

A vaccine preparation was obtained by γ irradiation of smallpox virus in chick embryo cultures. Results of a study of the immunogenic effects of the preparation in laboratory animals and experience in a small group of human subjects are reported. Inactivated antigen was prepared from trypsinized chick embryo cell cultures by irradiation with a dose of 5×10^6 rad of γ rays and was tested for the absence of live virus. Immunization with a single dose of noninfectious antigen prepared from irradiated vaccine virus from tissue cultures induced the formation of low levels of neutralizing and complement-fixing antibodies and antihemagglutinins in rabbits, guinea pigs, and monkeys and in human volunteers who had already been vaccinated against smallpox. Resistance to intracerebral challenge with virus was consistently demonstrated in mice after a single dose of antigen. Skin resistance to challenge with vaccine virus was not always present in rabbits and monkeys immunized with one dose of antigen and its level were low. The pathologic reaction of rabbits immunized with antigen to the administration of live virus was of shorter duration and was morphologically modified compared with the reactions of nonimmunized animals. Intradermal administration of antigen did not produce any local reaction in nonimmunized animals. Intradermal administration of antigen did not produce any local reaction in nonimmunized lab animals. Intradermal administration of irradiated vaccine in immune guinea pigs produced an irregular macular reaction. In human subjects immunized against smallpox in the past, the intradermal injection of irradiated antigen produced a maculopapular or vesicular reaction of the delayed hypersensitivity type. (BBB)

16272 ABSORPTION OF CESIUM BY WHEAT AND PEA PLANTS AS AFFECTED BY SOME CATIONS. Saddik, Kamel (Cairo Univ.). Lantbrukshoegsk. Ann., 29: 247-57(1963).

The uptake of ^{137}Cs by wheat and pea roots was determined. Wheat and pea plants were grown in a nutrient solution and used as 9-day-old plants to test the effect of some mono- and divalent cations on the absorption of ^{137}Cs from labeled CsCl solutions. Of the monovalent cations tested, K^+, Rb^+, Cs^+, and NH_4^+ considerably retarded the absorption of ^{137}Cs, whereas Na^+ and Li^+ did not significantly interfere. Results obtained with both wheat and pea resembled earlier findings with barley plants. It was also found that Ca^{2+} stimulated Cs^+ absorption by wheat and

pea plants. During a 2-hr experimental period, 1.7×10^{-3} M $CaCl_2$ increased the absorption of Cs^+ ~ 10% more than control values for wheat and nearly doubled the amount absorbed by peas. An effect similar to that of $CaCl_2$ was seen with $SrCl_2$ and the stimulatory effect increased as the concentration of the substrate Cs^+ increased. Higher concentration of $CaCl_2$ depressed the uptake of Cs^+. (BBB)

16273 RADIATION-CONDITIONED PROCESSES IN THE ORGANISM. Langendorff, H. (Univ., Freiburg i. B.). Elektromedizin, 6: 78-85(June 1961). (In German).

The phenomena and reactions that take place in a living organism during and after exposure to ionizing radiation are discussed. The relations between primary physical processes that take place during the absorption of high energy radiation and biochemical chain reactions that follow are described. Secondary biochemical reactions can not only be affected by physical factors, such as temperature, partial oxygen pressure, and water concentration, but also by the administration of chemical substances, such as cysteamine and serotonin; compounds that may reduce or increase radiation effects. In contrast to the assumption that chemical substances administered to an irradiated biological organism reduce partial oxygen pressure in cells or capture radicals and peroxides produced by the irradiation, it is now believed that chemically effective substances act as electron donors. Their effectivity is due to release of an electron which eliminates a radical of a vital molecule that was originally produced by irradiation. The results of tests made with pyridoxal-5-phosphate from vitamin B_6 seem to confirm this assumption. (BBB)

16274 DISTRIBUTION AND EXCRETION OF RADIOCESIUM IN GOATS, PIGS, AND HENS. Ekman, Lars (Royal Veterinary Coll., Stockholm). Acta Vet. Scand., 2: Suppl. 4, 83p(1961).

Radiocesium (^{134}Cs and ^{137}Cs) was administered per os to goats, pigs, and hens either as a single dose or in small daily doses, and its distribution in tissues and organs was determined at various times. The biological half-life of radiocesium was determined to be 31 days in goats and 27 days in hens. The corresponding half-life determined in pigs was ~18 days for growing animals and ~26 days for adult animals. Radiocesium was observed to be taken up more readily by physiologically active muscles than by inactive muscles, although in the long run inactive muscles had a higher content. The influence of potassium on radiocesium metabolism was studied by stable potassium determinations and by double-tracer tests with ^{42}K and ^{134}Cs in pigs. Results indicated that cellular uptake of cesium differed from that of potassium in that cesium was more readily accumulated in all tissues except blood cells and brain tissue. It was suggested that in future experimental work with animals on radiocesium metabolism that special attention be given to the influence of the stable cesium pool. Radiocesium was more readily taken up by some tissues, such as muscle, kidney, and salivary glands, than by others, but there was an appreciable time dependency. Generally, however, distribution patterns were fairly uniform. Excretion of radiocesium in the milk of goats during a 14-day period amounted to 14.5% of a single dose. Radiocesium did not accumulate in the udder of pregnant goats. In the hen, substantial amounts of radiocesium were deposited in eggs (2.5% of a single dose and 3% of repeated daily doses). (BBB)

16275 SOME IMPORTANT CONSIDERATIONS IN USE OF POWER FUNCTIONS TO DESCRIBE CLEARANCE DATA. Raabe, Otto G. (Univ. of Rochester, N. Y.). Health Phys., 13: 293-5(Mar. 1967).

A simple power function serves as an excellent mathematical model for certain types of data of clearance of radioactive material from biological systems. It has been employed to describe the relationship of excretion to body burden for various insoluble, long-lived radioisotopes. It has been used to describe the bone burden of ^{239}Pu, and for radium metabolism in humans and in many other investigations. Exponential functions have also been used to describe similar data, for example, the sum of three exponentials to describe the retention of ^{106}Ru and ^{239}Pu. This model involves more parameters than does the power function. There seems to be a tendency to confuse the non-arbitrary time axis of the power function model with the arbitrary time axis of an exponential model. This confusion is clarified by consideration of the basis of the instantaneous clearance dynamics of each of these models. The use of the power function implies certain characteristics and restrictions which are not adequately described by the simple expression, $y = At^{-\lambda}$. However, the use of the differential equation from which this form is derived provides the important details of the power clearance model. Two of these important considerations are (a) that the time axis is not arbitrary for power clearance models, but must be zero at the instant exposure begins, and (b) that the coefficient of the power term, A, is a unique function of the exposure rate, the exposure time and the power exponent, λ. (auth)

16276 FORMATION AND DESTRUCTION OF PYRIMIDINE DIMERS IN POLYNUCLEOTIDES BY ULTRA-VIOLET IRRADIATION IN THE PRESENCE OF PROFLAVINE. Setlow, R. B.; Carrier, W. L. (Oak Ridge National Lab., Tenn.). Nature, 213: 906-7(Mar. 4, 1967). (ORNL-P-2584).

The ultra-violet irradiation of polynucleotides in solution results in the reversible formation of dimers of cyclobutane type between adjacent pyrimidine residues. Such dimers in DNA produce important effects in many biological systems. It has been found that the presence of proflavine during irradiation at 2537 Å inhibits formation of thymine dimers in DNA and that dimers produced in the absence of proflavine are destroyed by further irradiation in its presence. It has been suggested that the destruction of dimers in DNA consists of simple reversion to monomers and that this might be demonstrated by studies with an organised polymer consisting of strands of polydeoxyinosinic acid and polydeoxycytidylic acid. Such a polymer has already been used to show that the enzymatic destruction of uracil dimers by photo-reactivating enzyme in the presence of visible light consists of monomerisation. The present communication describes studies following up this suggestion. The data obtained indicated the hypothesis to be correct. (UK)

16277 CONTRIBUTION OF DIMERS CONTAINING CYTOSINE TO ULTRAVIOLET INACTIVATION OF TRANSFORMING DNA. Setlow, J. K.; Setlow, R. B. (Oak Ridge National Lab., Tenn.). Nature, 213: 907-9(Mar. 4, 1967).

It has been shown that dimers containing thymine in DNA irradiated at 2537 Å can be eliminated by further irradiation at this wavelength in the presence of proflavine, and it has been confirmed that this elimination represents splitting of the dimers. The present authors describe studies showing that the biological inactivation of ultra-violet irradiated transforming DNA from Haemophilus influenzae may similarly be reversed by irradiation in solutions containing proflavine. Investigation of the wavelength dependence of the reactivation, together with information on the reversal of different types of pyrimidine dimers, has made it possible to evaluate the role of dimers containing cytosine in inactivation. (UK)

16278 X-RADIATION SENSITIVITY OF DNA-ABILITY TO FORM SPECIFIC MOLECULAR HYBRIDS WITH ISOLOGOUS m RNA. Robev, S.; Marinovz, Z. (Inst. of Radiology and Radiation Hygiene, Sofia). Nature, 213: 935(Mar. 4, 1967).

The authors report a study of the radiosensitivity of the molecular property of DNA as regards its ability to form genetically specified molecular hybrids with correspondent messenger RNA, employing the nitrocellulose membrane filter technique described by Nigaard and Hall. The results revealed a very steep slope in the dose-response curve. "Complementarity" remained unchanged for a certain increase in dose, and until a critical point for chemical "defects" accumulation was reached, after which there was a sharp drop in hybrid formation, bringing the values of irradiated samples to those of unhybridized controls. It is stated that it may be possible from the data obtained to determine the number of breaks in DNA which may be sustained without affecting genetic capacity. When this damage has been exceeded there would theoretically be no chance for repair because of impossibility of complementation. (UK)

16279 ALPHA-HYDROXYBUTYRATE DEHYDROGENASE AND LACTATE DEHYDROGENASE ACTIVITY IN RAT AND MOUSE KIDNEYS DURING EXPERIMENTAL POISONING DUE TO URANYL NITRATE. Bastide, J.; Bastide, P.; Malet, P.; Turchini, J.-P.; Dastugue, G. (Faculte Mixte de Medecine et de Pharmacie, Clermont-Ferrand, France). Ann. Biol. Clin. (Paris), 24: 745-55(May-June 1966). (In French).

Enzyme activities were determined in homogenates of kidneys of rats and mice poisoned with uranyl nitrate. Mice received a single intraperitoneal injection of 1 ml of a 400-mg/l solution per 20 g body weight, and rats 1 ml of a 2-g/l solution per 100 g body weight. Samples of kidney were assayed 0, 24, 48, 72, and 96 hr post-treatment. Histologic examination revealed typical changes in the tubular epithelial cells; glomeruli showed only vascular congestion. α-Hydroxybutyric dehydrogenase (HBDH) activity underwent a marked change in rat kidney (~50% drop by 96 hr) and a less accentuated fall in mouse kidney (10 to 20% decrease). Plasma levels of HBDH activity increased in rats. Lactic dehydrogenase (LDH) activity showed a less pronounced fall in rat kidney (~20%) than in mouse kidney. LDH activity was not altered in rat plasma. The results obtained with LDH in kidney homogenates were confirmed by histochemical tests on kidney. (BBB)

16280 UPTAKE OF ^{45}Ca IN BUFO BUFO LARVAE HAVING NO ENDOLYMPHATIC SACS. Guardabassi, Antonietta; Lattes, Maria Grazia; Pennisi, Francesco; Clerici, Piera (Univ., Turin). Ric. Sci., 36: 857-61(Sept. 1966). (In Italian).

Only a low percentage of $^{45}CaCl_2$ is taken up by Bufo bufo larvae, in contrast with ^{45}Ca-lactate. When $^{45}CaCl_2$ was administered to larvae lacking their endolymphatic sacs, ^{45}Ca was directly taken up by developing skeletal pieces. Up to about half the amount of ^{45}Ca incorporated in about 10 days was found in the skeletal segments of the hind limbs. No statistically significant variations in ^{45}Ca uptake and deposition were produced by parathyroid hormone treatment under the present experimental conditions. These results are discussed and compared with those obtained in previous experiments by using ^{45}Ca-lactate. (auth)

16281 THORIUM VULNERABLE FACTOR. Alexander, B. (Beth Israel Hospital, Boston). Throm. Diath. Haemorrh., Suppl. No. 20, 415-22(1966).

Interest in the effects of Th and the related lanthanides and actinides on blood clotting originated in studies on the adverse effects on coagulation caused by the orthodox endotoxin-induced Schwartzman reaction, when Thorotrast was tested as the Schwartzman inducing agent. When ThO_2 was given intravenously to rabbits, coagulation was quickly and severely altered. This observation led to further studies with soluble salts of Th and of the rare earths elements. Results indicated that besides adversely affecting factor V in plasma, these elements inactivated a hitherto unrecognized clotting entity present in normal serum, which functions in intrinsic thromboplastin generation. The moiety was provisionally designated Th vulnerable factor (TVF), and a method for its assay was developed. The known properties of TVF are considered in detail. Colloidal ThO_2 (Thorotrast), thorium chloride, uranyl chloride, as well as salts of the related rare earth elements Nd, La, and Ce_2 selectively and progressively inactivate a specific serum constituent which is essential for thromboplastin formation. This inactivation is reversible by citrate or oxalate. The factor is not vulnerable to chlorides of Zn, Cu, Al, Hf, In, and Ga, elements chosen as valence charge counterparts of the rare earths. Substantial amounts of TVF are present in, or on the surface of, platelets. Thorium in the form of its chloride (3×10^{-4} M in serum) was 50 times more potent than the colloidal oxide. Inactivation by Th and related elements following their addition to serum is progressive, the effect becoming evident within 5 min following addition. Although colloidal ThO_2 can induce defective coagulation and hemorrhagic phenomena in rabbits, no human subject with congenital deficiency of this entity has yet been encountered. (BBB)

16282 ACCELERATED EXCRETION OF INTRATRACHEALLY ADMINISTERED RADIOCERIUM BY MEANS OF DIETHYLENETRIAMINEPENTAACETIC ACID. Trnovec, T.; Beno, M.; Pleskova, A.; Vladar, M. (Inst. of Occupational Hygiene, Brastislava). Cesk. Hyg., 10: 385-92(Aug. 1965). (In Slovak).

A study was made of the effectiveness of this chelating agent (DTPA) on the acceleration of excretion of intratracheally administered carrier-free solutions of $^{144}CeCl_3$ in rats. Rats were treated with 5 intraperitoneal injections of 100 μM DTPA each, at two-day intervals, starting with the 2nd and 15th day. The analysis of the radioactivities in organs in the test and control animals was carried out on the 14th and 28th day. When DTPA administration was started on the 2nd day, an increase of the urinary excretion of radiocerium and a decrease of the fecal excretion were observed. When administration was started on the 15th day, the urinary excretion as well as the transient fecal excretion increased. The total amount excreted was 3.5 times higher if the administration of DTPA was started early and 1.8 times higher after delayed administration, compared with the control group excretion levels. A decrease of the activity in organs was also achieved. Thus, after delayed start of a series of DTPA injections the effect was lower than when treatment started early. (BBB)

16283 ADENOSINE MONOPHOSPHATE AS THE FIRST PHOSPHORYL ACCEPTOR IN OXIDATIVE PHOSPHORYLATION. Ozawa, Takayuki (Univ. of Wisconsin, Madison). Arch. Biochem. Biophys., 117: 201-23(Nov. 1966).

It was found that AMP as well as ADP could release the controlled respiration of beef heart mitochondria. Stoichiometric measurements showed that, when AMP was the exogenous phosphoryl (^{32}P) acceptor, the value of the molar ratio ($^{32}P_i$ incorporated/AMP added) was 1.0; the ratio (μmoles AMP/μatoms extra oxygen absorbed) was 2.5 (substrate, pyruvate plus malate); the corresponding P/O ratio was 2.5; the molar ratio (ATP labeled/ATP formed) was 1.0. These ratios were not affected by the addition of ATP to the mitochondria prior to AMP addition. The ATP formed when AMP was the added phosphoryl acceptor was exclusively doubly labeled. This was demonstrated by techniques involving column chromatography and enzymic analyses (with hexokinase and myokinase). However, when ADP was added, the values of the ratios were, respectively: ($^{32}P_i$ incorporated/ADP), 0.48; (ADP/O), 5.1; (P/O), 2.5; and (ATP labeled/ATP formed), 0.45. In these circumstances the ATP formed was about 15% doubly labeled and about 30% terminally labeled. When AMP was the added phosphate acceptor, the initial rate of $^{32}P_i$ incorporation (1-2 seconds) was at least twice that observed when ADP was the added acceptor. These results are interpreted as evidence that AMP is the first exogenous acceptor of the phosphoryl group in oxidative phosphorylation, and that release of respiratory control by ADP is mediated through a myokinase reaction. The relative amounts of adenine nucleotides found in the reaction products varied with time of sampling. When AMP was added as phosphoryl acceptor it was found that, at the point of transition of respiration from state 3 to state 4, the nucleotides formed were equally divided between "AMP" and doubly labeled ATP. However, 3 minutes after the transition, a decrease was demonstrated in the amounts of both "AMP" and ATP formed; and an equivalent formation of labeled ADP was demonstrated. When ADP was the nucleotide added as phosphoryl acceptor, the nucleotides formed at the transition point consisted of 25% "AMP," 30-35% labeled ATP, and 40-45% unlabeled ATP. Three minutes later a redistribution of nucleotides was demonstrated with the formation of ADP. From a consideration of these findings and other supporting data it is postulated that the pathway of phosphorylation of exogenous ADP is as follows: 4 ADP → 2 ATP + 2 AMP (external myokinase); 2 AMP + $2P_i^*$ → 2 ADP* (oxidative phosphorylation); 2 ADP → AMP + ATP** (internal myokinase). The apparent failure of the AMP produced in the last reaction to recycle is explained by the finding that the "AMP" found in the reaction products is not in a form which can act to release respiratory control but is in fact probably an acylated AMP. In the case of the mitochondria used in these studies, this product is not rapidly reconverted to free 5'-AMP. Whether AMP is a product of another reaction in the phosphorylation pathway (synchronous with the last 2 reactions given) or of a completely independent process is not known. (auth)

16284 CHANGES OF AMINO ACIDS AND ACTIVITY BY X-IRRADIATION OF CRYSTALLIZED LYSOZYME. Dose, K.; Risi, S.; Rauchfuss, H. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 3: 202-6(1966). (In German).

Crystallized lysozyme was x-irradiated with doses between 1 and 100 Mrads. Doses of a few Mrads had no measurable effect on activity and quantitative amino acid composition of lysozyme. However, increasing doses successively converted the original protein into a large number of modified proteins that possessed lysozyme activity. Only x-ray doses of the order of magnitude of 100 Mrads produced amino acid changes that could be clearly determined with an automatic amino acid analyzer. The G-values for the destruction of the various constituent amino acids were between 3 and 13. The larger sensitivities have the S-containing and aromatic amino acids as well as the long chain aliphatic amino acids. A comparison with other results showed that the radiation sensitivity of the constituent amino acids of solid proteins was not significantly influenced by other factors such as O_2-pressure, water content or protein structure. (auth)

16285 MODIFICATION OF RENAL STRONTIUM AND CALCIUM EXCRETION BY FURSEMIDE. Schenkel, R.; Schmid, A. (Univ., Munich). Arch. Pharmakol. Exp. Pathol., 255: 66-7 (1966). (In German).

Young female rats were fed Sr for 6 or 30 days until the ash content of the bone reached values of 4 to 8% and the plasma concentrations reached 3 to 6 mg%. Then the animals were subcutaneously injected with solutions of 0.05, 0.2, or 0.4% of fursemide in 5.5% glucose. Urine was collected from the animals for the ensuing 6 hr, and its Sr and Ca content determined by flame photometry. The results showed that fursemide increased the renal excretion of Sr and Ca in proportion to the dose used, for the period studied. The Sr/Ca discrimination factor in the animals fed Sr for 6 days was increased by fursemide treatment, and the Sr/Ca discrimination factor was decreased in the animals fed Sr for 30 days. These results were taken to reflect differences in renal tubular reabsorption of Sr and Ca caused by the fursemide. (BBB)

16286 EFFECT OF ANTIBIOTICS ON IMMUNOLOGICAL SPECIFICITY OF PROTEINS IN ACUTE RADIATION SICKNESS. Mil'man, M. Sh. (Research Inst. of Roentgenology, Radiology, and Oncology, Ministry of Health, Uzbek SSR). Byull. Eksp. Biol. Med., No. 11, 85-7(Nov. 1966). (In Russian).

Groups of rabbits were injected with penicillin, streptomycin, or oxytetracycline 15 minutes before the animals were x-irradiated (600 R). The immunological specificity of liver proteins in the irradiated animals was studied by the method of anaphylaxis with desensitization in guinea pigs. A water-salt extract from the liver of the irradiated rabbits was used as antigen. Changes were noted in the immunological specificity of liver proteins of the irradiated animals within 30 minutes of exposure. After 6 hours the changes were so great that one guinea pig died of antiphylactic shock. Penicillin was found to have exerted no significant effect on the time that the antigenic changes appeared in the

liver proteins or on the nature of the anaphylactic reaction in the guinea pigs. However, antigenic changes were not manifested in the animals that received streptomycin and oxytetracycline until 6 hours after irradiation; anaphylactic shock was mild. It was concluded that these two antibiotics interfered with the processes that bring about alterations in the antigenic structure of proteins after irradiation. (auth)

16287 INFLUENCE OF DRUGS ON INTESTINAL CIRCULATION AND THE ABSORPTION OF TRITIUM-LABELED WATER IN THE SMALL INTESTINE OF RATS. Winne, D. (Univ., Tuebingen, Ger.). Arch. Pharmakol. Exp. Pathol., 254: 199-224(1966). (In German).

In urethan-anesthetized rats, tritiated water (HTO) in isotonic saline was injected into or continuously perfused through the lumen of a jejunal loop. The venous outflow of the loop (its blood flow), its blood HTO concentration, and amount of HTO (absorption rate) were determined. The loss of blood was substituted by an appropriate infusion of blood. When HTO was injected into the jejunal loop, the HTO blood concentration and absorption rate decreased exponentially. The decrease was proportional to the blood flow. When the HTO was perfused through the lumen of a loop, the HTO blood concentration and absorption rate were constant in relation to time. With increased blood flow the HTO blood concentration decreased and the HTO absorption rate increased. The unidirectional water flux (lumen-interstitial space) was 0.692 in female and 0.337 μl/min-mg (dry weight) in male rats. The net water flux was nearly zero. About 17% of the intestinal blood supply flows through capillaries near the epithelium. Intravenous infusion of 5-hydroxytryptamine (8 μg/min), norepinephrine (6 μg/min), and vasopressin (20 milliunits/min) resulted in a reduced blood flow and HTO absorption rate, and a raised HTO blood concentration. Intravenous infusion of histamine (50 μg/min) or an intravenous injection of 150 μg atropine caused a brief increase of blood flow and HTO absorption rate, and a decrease of HTO blood concentration. Intravenous injection of 3 mg mersalyl and 15 μg neostigmine had no effect on the blood flow, HTO absorption rate, and blood HTO concentration. All the observed changes in HTO absorption rate and blood concentration can be explained by changes in blood flow. The results show the relation of intestinal blood flow to the absorption rate of tritiated water, used as a water-soluble substance per se. It is concluded that the absorption of water-soluble drugs may be similarly influenced by the intestinal blood flow. (BBB)

16288 RATIONAL DOSAGE OF RADON BATHS IN RELATION TO THE URICOSURIC EFFECT. Kolominsky, Jiri (Inst. for Experimental Physiotherapy, Balneology, and Climatology, Karlovy Vary, Czech.). Fysiatr. Vestn., 42: 144-52(1964). (In Czech).

The effect of the radiation dose during balneotherapy with Rn-containing mineral water on uricosuria was examined. Elimination of uric acid in the urine was studied in 85 patients on a standard purine-free diet in a clinical experiment during administration of Rn in baths at different concentrations and during placebo baths. In the 2- to 3-day preliminary period, during which the patients had no treatment except the diet, the daily elimination of urate diminished to 500 to 700 mg. In the next stage of the experiment, during the radon baths, at 100 nC/l and 75 nC/l (275 and 180 Mach units) concentrations, the Rn increased significantly the elimination of uric acid in urine. This increase was not observed in patients who had baths with a 10-nC/l Rn concentration. No difference was found in the elimination of urate when the Rn baths were used at different temperatures (38, 36, and 33°) or aerated. (TSS)

16289 INFLUENCE OF 19-NORTESTOSTERONE PHENYLPROPIONATE (SUPERANABOLON) ON ERYTHROPOIESIS OF NORMAL AND IRRADIATED RATS. Travnicek, T.; Neuwirt, J.; Janousek, V.; Broulik, P.; Taborsky, J.; Taborska, E. (Karlovy Univ., Prague). Sb. Lekar., 68: No. 4, 105-8(1966). (In Czech).

Studies on the effect of an anabolic steroid on blood cell formation following sublethal irradiation were conducted in 72 male Wistar rats weighing ~200 g. The rats were divided into 4 groups of 18 animals each and treated as follows. The first group served as controls. The rats of the second group were given subcutaneously every third day 2.5 mg 19-nortestosterone phenylpropionate per 100 g body weight. The animals of the third and fourth group were exposed to a single whole-body dose of 600 R, and the animals of group four were given the steroid treatments as in group two. On the 3rd, 7th, and 14th day, in each group 6 rats were killed and examined. Determinations were made of body weight, and blood levels of hemoglobin, hematocrit, red cells, and reticulocytes. Bone marrow function was also determined by the ^{59}Fe uptake of marrow of various bones. The results showed that this anabolic steroid stimulated erythropoiesis in normal rats and assisted in its restoration in sublethally irradiated rats. (BBB)

16290 INFLUENCE OF HYDROCORTISONE ON ERYTHROPOIESIS IN NORMAL AND IRRADIATED RATS. Travnicek, T.; Neuwirt, J.; Janousek, V.; Broulik, P.; Taborsky, J.; Taborska, E. (Karlovy Univ., Prague). Sb. Lekar., 68: No. 4, 109-12(1966). (In Czech).

Male Wistar rats weighing 210 g were divided into four groups of 18 animals. The first group served as controls. The rats of the second group were administered daily subcutaneously 1 mg hydrocortisone acetate per 100 g body weight. The animals of the third and fourth groups were exposed to a single whole-body dose of 600 R and the animals of group four were also given hydrocortisone, as in group two. On the 3rd, 7th, and 14th day, in each group 6 rats were killed and examined. Determinations were made of body weight, blood levels of hemoglobin, hematocrit, erythrocytes, and reticulocytes. The incorporation of ^{59}Fe in the marrow of various bones was also recorded. The results showed that hydrocortisone reduced within 14 days the body weight of experimental rats, did not stimulate erythropoiesis in normal rats, and inhibited erythropoiesis in irradiated rats. Changes which were noted in the number of red cells after administration of hydrocortisone were probably due to changes in the distribution and circulation of blood. (BBB)

16291 LABELING OF PROTEINS WITH THE AID OF RADIOIODINE BY AN ELECTROCHEMICAL METHOD: EFFECT OF PROGRESSIVE IODINATION ON THE METABOLIC BEHAVIOR OF HUMAN SERUM ALBUMIN. Rosa, U.; Bianchi, R.; Federighi, C.; Scassellati, G. A.; Donato, L. (Centre di Richerche Nucleari, Saluggia, Italy). Bull. Schweiz. Akad. Med. Wiss., 21: 185-96 (1965). (In French).

Detailed data on the technique and apparatus for electrolytic labeling of proteins with radioiodine are given. The radioiodine liberated by electrolysis of an aqueous solution of potassium iodide–^{131}I reacts with the protein. Effects of radioiodination on the biological properties of the proteins were examined. Correlation between the radioiodination degree and the metabolic behavior of ^{131}I-labeled human serum albumin is reported. The chemical modifications induced into the protein by the iodination are chiefly the formation of mono- and di-iodinated tyrosine residues and the progressive iodination of SH groups. The former effect is seen upon total hydrolysis of the iodinated protein followed by chromatographic analysis of the hydrolysate, the latter by amperometric titration of the SH groups. When protein labeling is carried out by the described electrolytic method, the protein can be iodinated under reproducible conditions. The experimental results revealed that the progressive oxidation of SH groups has no effect on the metabolic behavior of the serum albumin. However, it is substantially modified when the iodination degree (iodine atoms per protein molecule) is higher than 6. (BBB)

16292 MICROSPECTROPHOTOMETRIC DETERMINATION OF AMOUNT OF DNA IN IRRADIATED MAMMALIAN CELLS GROWN IN VITRO. Dutt, Mihir K. (Univ. of Delhi); Kaufmann, Berwind P. Nucleus, 9: 21-38(June 1966).

Measurements were made of the changes in DNA content among the progeny of irradiated cells in a stable diploid line of human skin fibroblasts for comparison with similar data obtained from irradiated tissue-culture cells of human carcinomatous origin (the HeLa B strain). Spectrophotometric analysis, using the 2-wavelength method in analysis of Feulgen-stained material, showed that in both fibroblast and HeLa cells the giant forms induced by the action of x rays contained amounts of DNA that were significantly higher than those detectable in unirradiated control cells, but that the extent of change was far greater in the heteroploid HeLa cells than in the skin fibroblasts. Thus there was a much greater variability in the amount of DNA within nuclei of a particular size of HeLa cells than was detected in measurements of the fibroblasts. This was interpreted as due in part to a slow rate of DNA synthesis in the irradiated group. Some support for this assumption was provided by the light transmission data for these cells. Within the HeLa cell population 40-fold differences in DNA content were detected. Microscopic examination of cells stained by the alkaline fast-green method suggested that the total histone content was slightly less in the irradiated cells than in the controls. It is suggested that the action of irradiation is on the deoxyribonucleoprotein and that it alters the ration of DNA to basic protein. (BBB)

16293 EFFECT OF RENAL FAILURE ON WOUND HEALING IN DOGS: RESPONSE TO HEMODIALYSIS FOLLOWING UREMIA INDUCED BY URANIUM NITRATE. Nayman, J. (Alfred Hospital, Melbourne). Ann. Surg., 164: 227-35(Aug. 1966).

Irreversible and reversible patterns of renal failure were induced by dogs by intravenous injection of 5 mg/kg body weight of uranium nitrate; in a few animals the dose of uranium nitrate was either increased or decreased. Three patterns of U-induced renal failure were studied: irreversible acute renal failure (all

animals died); reversible (recoverable) acute failure (in this group wound healing could be studied in relation to both development of and recovery from renal failure); and compensated chronic renal failure (induction of acute renal failure was followed by recovery and persistently elevated blood urea levels). It was assumed that administration of uranium nitrate would be unlikely to affect wound healing for the following reasons: (1) The effects of uranium nitrate on renal tubules are noted promptly and its excretion is almost complete within 24 hr; the effect of uremia on the wound is only manifested days later and is related to the degree of renal failure. (2) The renal tubule can be protected from the action of uranium nitrate by administration of sodium carbonate. (3) Prevention of wound dehiscence by hemodialysis, as shown later, using the same dose of uranium nitrate was evidence that this heavy metal is not responsible for failure of the wounds to heal. Induction of acute renal failure within the first 6 to 7 days following laparotomy resulted in wound breakdown, whereas induction of acute renal failure after the eighth day following laparotomy had no effect upon the wound. It appeared that wound disruption can be prevented by instituting early and frequent hemodialysis. (BBB)

16294 INFLUENCE OF CHELATING AGENTS ON THE EXCRETION AND THE BEHAVIOR OF MERCURY IN ACUTE MERCURY POISONING. Eybl, V.; Sykora, J.; Mertl, F. (Univ., Karlova, Plzen, Czech.). Arch. Exp. Pathol. Pharm., 252: 79-84(Nov. 4, 1965). (In German).

The use of chelating agents to increase the excretion of ^{203}Hg in acute poisoning experiments was studied in adult rats. Doses of 500 μg Hg (1 to 2 μC/kg ^{203}Hg) were given, followed by chelating agents. The action of N-acetyl-D,L-penicillamine (N-APA) and 2,3-dimercaptopropanol (DMP) on the excretion of radiomercury was compared. N-APA administered per os and intraperitoneally did not increase the excretion of radiomercury; DMP was more effective. With increasing doses of DMP the excretion of radiomercury was markedly increased. This effect was not observed after application of N-APA. The results of these experiments suggest that the protective action of N-APA is based on the formation of insoluble complexes, which are not excreted. (BBB)

16295 EFFECT OF CORTICOSTEROIDS AND IRRADIATION UPON CHOLESTEROL BIOSYNTHESIS IN THE LIVER OF ADRENALECTOMIZED RATS. Tret'yakova, K. A. (All-Union Inst. of Experimental Endocrinology, Moscow). Vop. Med. Khim., 12: 502-7(Sept.-Oct. 1966). (In Russian).

A study was made of the effect of corticosteroid on cholesterol biosynthesis in the liver of irradiated rats. Cholesterol biosynthesis in rat liver was stimulated by cortisone acetate. Desoxycorticosterone inhibited this process in vivo and in vitro. Adrenalectomized rats did not lose ability to increase cholesterol biosynthesis under irradiation. This phenomenon depended on the time after operation and supply of sodium chloride. (auth)

16296 FORMATION OF OXIDATION PRODUCTS OF UNSATURATED FATTY ACIDS IN REGENERATING NORMAL AND WHOLE BODY IRRADIATED RAT LIVERS. Zicha, B.; Benes, J.; Lejsek, K.; Simek, J. (Univ., Prague. Univ., Hradec Kralove, Czechoslovakia). Naturwissenschaften, 53: 613(1966). (In German).

The formation of oxidation products of unsaturated fatty acids was followed in rat livers after exposure to whole body irradiation at various periods following a partial hepatectomy. The decrease of the TBS chromogen occurring after partial hepatectomy is reciprocally proportional to the DNA level and attains its minimum at the maximum DNA value 24 hours after partial hepatectomy. The effect of ionizing radiation on the interphase exposure shortly after surgery and at the beginning and ending of the G_1 period of the generation cycle is tabulated. The radiation appears to inhibit the DNA synthesis induced by the partial hepatectomy and to reduce the mitotic index. The radiation causes no increase of the TBS reaction. (J.S.R.)

16297 ^{18}O LABELING OF DEOXYRIBONUCLEIC ACID DURING SYNTHESIS AND STABILITY OF THE LABEL DURING REPLICATION. Richards, O. C. (Univ. of Utah, Salt Lake City); Boyer, P. D. J. Mol. Biol., 19: 109-19(Aug. 1966). (TID-23056).

Methods are described for the ^{18}O and ^{32}P labeling of the phosphodiester bonds of Escherichia coli and of T2 phage DNA, together with results demonstrating lack of extensive hydrolytic cleavage and resynthesis of DNA during replication. The experiments also gave information about the relative rates of water ^{18}O incorporation into various phosphate fractions of E. coli and into T2 phage. In addition, the development of adequate methods for ^{18}O labeling of phosphodiester oxygens of E. coli and T2 phage DNA yielded information about metabolic reactions of phosphate compounds and about the source of oxygens in the deoxyribose moiety of the DNA. (TSS)

16298 EXCHANGE AND METABOLISM OF TRACE ELEMENTS IN FRESH WATER MUSSELS WITH SPECIAL REFERENCE TO ACCUMULATION MECHANISMS OF RADIONUCLIDES. Glaser, Roland (Institut fuer Angewandte Isotopenforschung, Berlin). Zool. Jahr. Abt. Allgem. Zool. Physiol. Tiere, 72: 1-114 (1966). (In German).

Metabolism of ^{58}Co, ^{65}Zn, $^{95}Zr-^{95}Nb$, and $^{144}Ce-^{144}Pr$ is intensively concentrated in the shells and tissues of Dreissensia polymorpha. In contrast to these radionuclides, ^{137}Cs is less intensively concentrated and reaches saturation factor of ~22 in the muscle within a month. All of the radionuclides studied were readily adsorbed onto the shell. The max concentration of ^{137}Cs reached was 70 to 80% of the value of nonradioactive K. The mineral concentrations did not vary through the year. The Ca concentration of Anodonta cyngnaea and Unio pictorum was greater than that of D. polymorpha. The resorption of Co, Zn, and Ce by the gastrointestinal tract was greater than that of the other metals studied. This appeared to be due to an active transport system in D. polymorpha and U. pictorum. From 30 to 50% was absorbed. Absorption was inhibited by dinitrophenol. Uptake of the radionuclides by the mantle tissues seemed to represent adsorption. Carrier effects were observed with ^{58}Co and ^{65}Zn. Only Cs uptake was affected by the K concentrations. Na had no carrier effects. Uptake of the radionuclides was reduced or prevented by addition of ethylenediaminetetraacetate. Formalin had no effects on uptake by the byssus or shell, but did increase permeability of the tissues measurably. The uptake kinetics of the radionuclides was analyzed compartmentally by an analog computer. The author describes in detail the materials and methods used, chemical states and properties of the radionuclides used, and the exchange and distribution of the radionuclides in vivo and in vitro in the shell and organs of the mussels studied. (BBB)

16299 REACTION VELOCITY OF THYMINE DIMERIZATION IN THE KINETICS OF UV INACTIVATION OF MICROORGANISMS. Pichl, Heinz. Zentralbl. Bakteriol., Parasitenk., Abt. I. Orig., 198: 205-6(1965). (In German).

In attempts to clarify the processes occurring in DNA in the uv-induced inactivation and subsequent photoreactivation of microorganisms, thymine was used as a model substance to measure the equilibrium constant and the reaction velocity of the dimerization reaction during uv irradiation. It was thereby found that the equilibrium constant and the reaction velocity constant, k_0, are dependent on the starting concentraction and the concentration of added extraneous substances. The value of k_0 fell with increasing concentration of thymine or added foreign substances. The simplest explanation of this finding is based on the assumption that the two reacting thymine molecules must be in an optimal relation to each other to combine. (BBB)

16300 UNCOUPLING OF OXIDATIVE PHOSPHORYLATION BY IONIZING RADIATION. Scaife, J. F.; Hill, B. (Dept. of National Defence, Ottawa). Can. J. Biochem. Physiol., 40: 1025-42(1962).

Whole-body irradiation of rabbits or rats with x rays or ^{60}Co γ rays caused uncoupling of oxidative phosphorylation in thymus mitochondria, which was not prevented by the prior administration of AET. Whole-body irradiation did not affect oxidative phosphorylation in liver of mouse ascites cell mitochondria. The radiation lesion could be repaired in vitro by the addition of cytochrome c, bovine serum albumin, or vitamin K_1 to mitochondria. Vitamin E and coenzyme Q_{10} were without effect. Both phosphorylating steps in the electron transport chain associated with succinate oxidation were affected by irradiation. The diphosphopyridine nucleotide dependent steps in the oxidation of α-ketoglutarate by thymus mitochondria were damaged by in vivo irradiation. Diphosphopyridine nucleotide levels of thymus and spleen but not liver or ascites cells were reduced by in vivo irradiation. No effect of in vitro irradiation on oxidative phosphorylation could be found for thymocyte cell suspensions, isolated thymus or liver mitochondria, or ascites or HeLa cell suspensions. Respiration of ascites or thymocyte cells was unaffected by in vitro irradiation. (BBB)

16301 HAPTOGLOBIN CHANGES IN CERVICAL CARCINOMAS DURING IRRADIATION. Graf, H.; Probst, H. (Univ., Tuebingen, Ger.). Med. Welt, 36: 473-80(Mar. 5, 1966). (In German).

Serum haptoglobin was measured in 43 cases of cervical carcinoma in Stages I to III before and during irradiation. Average normal values were 82 mg%, and values in Stage I, II, and III patients before irradiation were 111, 192, and 276 mg%, respectively. Single observations in Stage IV carcinomas gave values of ~370 mg%. The difference between normals and Stage I was not statistically significant. Irradiation consisted of 3 intrauterine treatments of 1200 mg-hr of Ra, each 14 days apart, and 3 intravaginal treatments of 960 mg-hr of Ra. All cases also received 3200 to 3400 R

focal dose by convergent pendulum irradiation. Haptoglobin concentrations were measured before irradiation and on 1, 3, 5, 7, 14, 21, 28, and 35 days of the treatment, as well as ¼, ½, and 1 yr after it was started. The max value in Stage I of ~160 mg% was reached on day 7 and fell by day 35 to the starting value. Max values reached by day 7 in Stage II and III were 260 and 300 mg%, respectively. These values dropped slowly toward the starting values over the 1-yr study period. In recurrent tumors the haptoglobin concentration before irradiation was 364 mg%. This increased to 691 mg% after 1 yr. References cited, 75. (BBB)

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Refer also to abstracts 16039, 16093, 16340, and 16342.

16302 RADIOACTIVITY IN THE PLANKTON OF LAKE LUCERNE; UPTAKE OF ^{90}Sr–^{90}Y AND ^{89}Sr BY PLANKTON. Bezzegh-Galantai, Maria-Magdalena; Pavoni, Marianne (Institut Federal pour l'Amenagement, l'Epuration et la Protection des Eaux Annexe a l'Epf, Zurich). pp 107-25 of STI-PUB-126. (In French).

A series of radioactivity measurements were made on plankton samples from the epilimnion of Lake Lucerne to determine the response of fresh-water plankton to radioactive isotopes. The samples were taken regularly once every month, from the end of 1962 to the end of 1965, primarily to assess quantitatively any increase of radioactivity in the plankton due to fallout from the atmosphere. Results from the observations made over the three-year period showed that: fallout material is accumulated both in the phytoplankton and in the zooplankton, and the activity remaining in the water is barely measurable; activity of the phytoplankton is higher (up to 10 times) than the activity of the zooplankton; and specific activities of both types of plankton are subject to seasonal variations. The low concentrations of radioactivity found in the plankton samples permitted the determination of total beta activity only. Hence the response of plankton to single isotopes had to be investigated in vitro. In a first series of such experiments the important isotopes $^{90}Sr-^{90}Y$ and ^{89}Sr were tested. Preliminary results of these model experiments are given. (tr-auth)

16303 INTERACTIONS OF THE ENVIRONMENTAL AND BIOLOGICAL FACTORS ON THE DISTRIBUTION OF TRACE ELEMENTS IN THE MARINE ENVIRONMENT. Lowman, F. G.; Phelps, D. K.; McClin, R.; Roman de Vega, V.; Oliver de Padovani, I.; Garcia, R. J. (Puerto Rico Nuclear Center, Mayaguez). pp 249-66 of STI-PUB-126.

Investigations are described in which the distribution of radioisotopes of fallout and stable cadmium, iron, nickel, zinc, copper, rubidium, strontium, cobalt, manganese and scandium are measured in the marine organisms and their environment. The geographical areas of research include a marine environment adjoining a land mass receiving low amounts of rainfall, as well as three watersheds and estuaries of neighboring rivers which drain areas of different geological origin. The three watersheds receive large amounts of rain. Benthic, epibenthic and pelagic marine organisms are considered in relation to their environment with emphasis placed on the following considerations: (1) physical and chemical forms of the trace elements in the river water before and after mixing with sea water and the rate of change in form, (2) the relation of distance from a river outflow to the distribution patterns of stable elements in individuals of a benthic community, (3) the influence of the geographical location upon the accumulation of trace elements and radioisotopes by given epibenthic species and the amounts of variability in trace elements contained within individuals of a given species from one place, (4) patterns of accumulation of trace elements by closely related species for a restricted geographical area, (5) large differences in distribution patterns of trace elements within larger groups of organisms, and (6) trace elements and radioisotope distributions in food webs containing benthic, epibenthic and pelagic organisms. (auth)

16304 EXPERIMENTAL STUDY OF THE FIXATION ON PLANTS AND FISH OF RADIOISOTOPES ORIGINATING FROM PLUTONIUM PRODUCTION CENTRE EFFLUENT. Rodier, J.; Marichal, M.; Benoit, R. (CEA, Centre de Production de Plutonium, Marcoule, France). pp 519-33 of STI-PUB-126. (In French).

In view of the existence of wastes associated with operation of the Marcoule Centre, it was decided to investigate the radioactivity of the surrounding area. To take account of the specific aspects of contamination by selective fixation or reconcentration in the flora, fauna and sediments of the Rhone, experiments for following the activity trends of certain radioisotopes were conducted. The radiotoxic effect of effluent on fish was investigated; a study was also performed on the fixation of waste-borne radioisotopes on certain plants. For the work on plants, the study area consisted of a garden comprising five sealed basins capable of being irrigated by effluent-contaminated water. Three of the basins are assigned to growing legumes or annual plants, while the two others are used respectively for vines and for the most common fruit trees of the region. Each basin has a control plot. Reconcentration in the plants was studied for activities ranging from 0.05 mCi to 5 mCi per m^3 of ground. The radiotoxic action was studied in a basin of 100 m^3 capacity which could be filled with radioactive water via a tapping from the discharge channel of the Effluent Processing Station. It was thus possible to recreate, under well-defined conditions, a degree of contamination of the river ranging from 5×10^{-6} Ci/m^3 to 1×10^{-3} Ci/m^3. (tr-auth)

16305 EXPERIMENTAL CONTAMINATION OF MARINE SPECIES WITH ^{144}Ce, ^{106}Ru AND ^{95}Zr. Anceilin, J.; Vilquin, A. (CEA, Centre de la Hague, France). pp 583-604 of STI-PUB-126. (In French).

The experiment, performed at the marine radioecology laboratory at the La Hague Centre, is carried out in aquaria of 40- to 70-l capacity, containing seawater and operating as a closed circuit, provided with sediment composed of sand or gravel, and equipped with a filtration-aeration system. Each aquarium is contaminated with one of the three following radioisotopes: cerium-144, ruthenium-106 and zirconium-95. The specific activity of the water in the aquaria is of the order of 1 to 2 μCi/l. A certain number of species has been studied, either in isolation or preferentially with respect to others, and grouped in the same aquarium so as to reconstitute the biological environment observed along the northwest coast of the Cotentin Peninsula. Fairly high build-up factors are observed for cerium-144, particularly with respect to the algae Corallina officinalis (of the order of 10,000 to 20,000). For ruthenium-106 the build-up factors are lower (e.g., about 100 to 200 for the algae investigated). These results may be compared with data already published on the same or similar species. They confirm that the concentration capability often varies inversely to the degree of evolution of the organisms, at least as far as two of the fission products in question are concerned: ^{106}Ru and ^{144}Ce. As regards the concentration of cerium-144 in algae in particular, the values are higher than those mentioned in the literature. Differences have also been noted in the case of ruthenium-106. (tr-auth)

16306 ACCUMULATION AND LOSS OF ^{65}Zn BY OYSTERS IN A NATURAL ENVIRONMENT. Seymour, A. H. (Univ. of Washington, Seattle). pp 605-19 of STI-PUB-126.

Accumulation of ^{65}Zn by oysters was determined by the increase of this radionuclide in oysters that had been transplanted from Puget Sound or Hood Canal, areas in which ^{65}Zn was virtually absent, to Willapa Bay, where ^{65}Zn was present. Eight lots were transferred between February 1963 and March 1965. For the first 60 d after transfer the accumulation of ^{65}Zn, by lots, ranged from ½ to 2 pCi/g (dry)/d; after 200 d the rate for all lots was approximately ¼ pCi/g (dry)/d. Seasonal and annual differences in accumulation immediately after transfer were evident: accumulation rates generally decreased from spring to fall and from 1963 to 1965. The steady-state condition was not reached until after 500 d. Loss was determined by the decrease of ^{65}Zn in oysters transplanted from Willapa Bay to Puget Sound or Hood Canal. Unlike the rate of accumulation the rate of loss was relatively constant and for all lots considered collectively was estimated to be 0.55%/d. The effective and biological half-lives were estimated to be 125 and 255 d, respectively. Willapa Bay oysters concentrated zinc by a factor of 1.5×10^4. This value was calculated from a wet-dry ratio of 6.0 and previously reported zinc values of 515 μg/g (dry) for oysters and 7.37 μg/l for seawater. (auth)

16307 EVALUATION OF RADIATION DOSE TO MAN FROM RADIONUCLIDES RELEASED TO THE CLINCH RIVER. Cowser, K. E. (Oak Ridge National Lab., Tenn.); Snyder, W. S.; McCammon, C. P.; Straub, C. P.; Kochtitzky, O. W.; Hervin, R. L.; Struxness, E. G.; Morton, R. J. pp 639-71 of STI-PUB-126.

Low-level contaminated waste water, generated by the operations at ORNL, has been released to the Clinch River near Oak Ridge for the past 20 yr under controls consistent with the recommendations of ICRP and NCRP. Evaluation of radiation exposure doses to populations downstream, on the basis of long-term monitoring data and the identification of critical exposure pathways and critical population groups, has been the objective of the Clinch River Study. Knowledge of water utilization downstream indicates that the important avenues of exposure resulting from discharge of radioactive fluids to the Clinch River include: (1) consumption of contaminated water and fish, (2) consumption of agricultural produce that may be irrigated with river water, (3) exposure to contaminated water and bottom sediments during recreational and industrial use of the water, and (4) exposure to build-up of radionuclides in sludge and deposits in water systems utilizing river water. The major sources of exposure are currently the ingestion of contaminated

water and fish. Mathematical models are developed for internal dose calculations and include the differences in intake and size of the critical organ as a function of the individual's age. After 20 yr of drinking river water, the skeleton of man receives the largest exposure. Strontium-90 is responsible for more than 99% of the skeleton dose. At the end of 1963 the dose rates to the skeleton of the potentially critical population groups (individuals 14-yr old at the beginning of the exposure in 1944) are 0.19 rem/yr and 0.026 rem/yr for the Clinch River and Tennessee River, respectively, and are about twice that received by standard man. Consumption of 37 lb/yr of the flesh of Clinch River fish (bottom feeders) contributes about the same annual intake of ^{90}Sr as drinking water. The largest dose rates from immersion in contaminated water and contact with contaminated bottom sediments are calculated to be 0.027 mrad/24 h and 12 mrad/24 h, respectively. Dose rates in water treatment plants using Clinch River water are at background levels (0.01 to 0.02 mR/h). Based upon realistic but conservative assumptions, the estimated cumulative doses (20-yr period) received by the skeleton of the critical population groups, the 18-yr-old individual (in 1944) utilizing the Clinch River and the 14-yr-old individual (in 1944) utilizing the Tennessee River, are 3.2 rem and 0.45 rem, respectively. Methods of calculation are presented, and examples are given for the transfer of ^{90}Sr and ^{137}Cs to man by irrigation water. If irrigation is practiced in the future, it may become the dominant exposure pathway. (auth)

16308 EVALUATION OF THE EXPOSURE RESULTING FROM THE DISPOSAL OF RADIOACTIVE WASTES INTO THE COLUMBIA RIVER. Foster, R. F.; Soldat, J. K. (Battelle Memorial Inst., Richland, Wash.). pp 683-96 of STI-PUB-126.

People who use the Columbia River downstream from the Hanford atomic energy complex may receive small increments of the permissible amounts of radiation exposure from radionuclides released to the river. Comprehensive studies have been made of the ways in which this exposure can occur, the nuclides and exposure pathways of greatest significance, the characteristics of the exposed population, and the probable magnitude of the exposure. The food chains of greatest significance involve local fish and the produce from a few irrigated farms. In each of these food chains, the neutron activation products ^{32}P and ^{65}Zn are of greatest importance. The short-lived nuclides ^{24}Na, ^{76}As, ^{239}Np, and ^{131}I have greater significance in drinking water than in food chains that start with river water. The ^{24}Na also contributes some external exposure to persons who swim in the river. Chromium-51 is the most abundant nuclide in the river, but it is not concentrated in food chains and makes a relatively insignificant contribution to human exposure. Evaluation of the total exposure received by people in the neighborhood of the Plant requires consolidation of the contributions from the river with the exposure from pathways that involve the atmosphere. The individuals that receive the greatest dose are persons who eat unusually large quantities of fish caught in the river immediately downstream from the reactors. The dose estimated for the bone of these individuals exceeds that estimated for other organs because of the ^{32}P content of the fish and the ^{90}Sr (from worldwide fallout) content of other foods. For the vast majority of people who live in the vicinity, drinking water provides the only source of water-borne radionuclides and the gastro-intestinal tract is the organ that receives the greatest exposure. Atmospheric pathways are responsible for virtually all of the intake of long-lived nuclides. Whole-body counting of large numbers of local people has shown that the intake of radioactive materials from the Hanford Plant is less than that estimated by common dietary assumptions. These exposure evaluations confirm that the total dose to members of the public has always been well within appropriate limits and that the radioactive wastes generated by the plants have been under sound and continuous control. (auth)

16309 RADIOACTIVE CONTAMINATION OF NORTH SEA FISH. Feldt, W. (Bundesforschungsanstalt fuer Fischerei, Hamburg, Ger.). pp 739-52 of STI-PUB-126.

During the cruises of the research vessel Anton Dohrn (1963 to 1965), fishes were caught from the whole North Sea. Fish samples, including cod, herring, haddock, redfish and others were separately analyzed for their content of ^{90}Sr and ^{137}Cs. Extensive studies have clearly demonstrated the distribution pattern of these radionuclides in the different organs. Some data on ^{54}Mn contamination are also given. On the basis of numerous measurements of the calcium and inactive strontium in fish (100 analyses), the discrimination factor fish–water could be calculated. From graphic representation it could be recognized that the value of this discrimination factor ranged from 0.1 (herring) to 0.4, with a clear maximum at 0.22. These figures permit the calculation of the intensity of fish contamination if the contamination of water is known and vice versa. Based on the assumption (which is experimentally proved) that the specific activity $^{90}Sr/Sr$ is the same both in organisms and in water, an equation is derived which relates and postulates the dependence of the $^{90}Sr/Ca$ contamination in fish to the calcium content in water. The validity of this relation finds support in many analyses of Baltic and fresh-water fishes. The progressive increase in the ^{90}Sr and ^{137}Cs content of coastal water, fish, mussels and shrimps during the last 6 years is shown. Related to the problem of how marine food contributes to the contamination of man, the relation between the contamination of fish and fish products is investigated. (auth)

16310 BIOLOGICAL RESPONSE OF RAINBOW TROUT (SALMO GAIRDNERI) INGESTING ^{65}Zn. Nakatani, R. E. (Battelle Memorial Inst., Richland, Wash.). pp 809-23 of STI-PUB-126.

Zinc-65 is one of the dominant radionuclides identified in fishes sampled from the Columbia River and off the coasts of Washington and Oregon. Radiation damage has not been observed in these fish, nor is it expected, because of the extremely low levels of ^{65}Zn present. Laboratory work on the biological response of rainbow trout force-fed relatively high levels of ^{65}Zn is reported. After a single dose, fish rapidly excrete ^{65}Zn for several days, primarily through the gastrointestinal tract and gills. Data on the distribution and retention of ^{65}Zn in various tissues showed high concentrations in the gills, gastrointestinal tract and bone. The high concentration observed in the gills is associated with excretion. The gastrointestinal tract contained about 30 to 50% of the body burden after both chronic and single feeding. Little ^{65}Zn is excreted in the urine. Growth, mortality, hematology, histopathology and swimming performance were studied as related to chronic ingestion levels. Groups of trout fed ^{65}Zn at a daily rate of 0.01, 0.1 and 1.0 μCi/g fish for 17 weeks differed insignificantly from controls. No deaths occurred, and growth of the ^{65}Zn-fed fish exceeded that of the controls. However, damage was indicated when fish were fed at a rate of 10 μCi/g fish for 10 weeks. Blood samples showed no anomalies in hematocrit, hemoglobin or erythrocytes, but leucopenia was indicated. Histopathologic examinations of the liver, kidney, spleen, bone, gastrointestinal tract and gills showed no evidence of tissue damage with the exception of the gill filaments. Because trout with a 10,000 times greater burden of ^{65}Zn than river fish showed no detrimental effect, there is considerable assurance that Columbia River fish populations are not adversely affected by the present levels of ^{65}Zn in the Columbia River. (auth)

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Refer also to abstracts 16495, 16513, 16523, 16524, and 16549.

16311 (AD-641505) CHROMOSOMAL DAMAGE IN HUMANS PRODUCED BY X-IRRADIATION. Annual Progress Report. Louro, Jose M. (Brooke General Hospital, Fort Sam Houston, Tex.). 1966. 21p. CFSTI $3.00 cy, $0.65 mn.

The chromosomes of peripheral leucocytes in subjects exposed to more than 2500 R of x-irradiation were compared with those of normal, healthy individuals and several other subjects not exposed to x-irradiation. The results revealed that in the irradiated group there was a marked increase in aneuploidy, polyploidy, endoreduplication and structural chromosomal damage. (auth)

16312 (ORO-2976-13) GENETIC AND CYTOGENETIC ANALYSIS OF THE EFFECTS OF RECURRENT IRRADIATION AND CHEMICAL MUTAGENS ON GENERAL AND SPECIFIC COMBINING ABILITY IN PEARL MILLET, PENNISETUM TYPHOIDES, (P. GLAUCUM). Progress Report, May 1, 1966–April 30, 1967. Burton, Glenn W.; Powell, Jerrel B. (Georgia Univ., Tifton. Georgia Coastal Plain Experiment Station). Feb. 14, 1967. Contract AT(40-1)-2976. 83p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

During the current contract period, measurements of combining ability on second- and third-cycle treatments were reported, a new mutagen-treatment series was tested on reselected inbred lines of pearl millet, and mutations of possible economic, breeding, or genetic value were isolated. Significant differences in dry-matter yields were observed for inbreds and treatments. General and specific combining ability were altered by mutagen treatment. No consistent pattern of variation could be resolved from this first year of evaluation, but the trend in the mutagen-treated material seemed to be toward a higher proportion of non-additive genetic variance. A new mutagen treatment series, given to five reselected inbred lines of pearl millet (free of chlorophyll-deficient seedling mutations) showed that the 65-minute thermal neutron (TN) dose (1.5×10^{13}/cm^2/sec.) induced chlorophyll-deficient seedlings in approximately 11% of the M_1 plants. The soaking of TN-treated seed in .2% ethyl methane sulfonate (EMS) or .1% diethyl sulfate (DS) added approximately 3% more mutants. Seed weight per head (fertility) was least affected by the .1% DS treatment and most affected by the TN-60 + EMS .002 treatment. Mutations isolated during the course of these studies have included dwarfs, yellow node and sparse spikelet mature-plant mutants, and many different chlorophyll-deficient seedling mutations. (auth)

16313 CHROMOSOME REPRODUCTION. Taylor, J. Herbert (Columbia Univ., New York). Int. Rev. Cytol., 13: 39-73(1962).

Use of ionizing radiation for study of chromosome reproduction is reviewed. Although present evidence indicates that x rays and especially other more densely ionizing particles, such as protons and α particles, can break two separate chromatids simultaneously, radiation is an extremely useful tool for studies of chromosome duplication. Reviewed data indicated a definite correlation between types of radioinduced aberrations and the time of synthesis of DNA and basic proteins; as soon as chromosomes are reproduced, the new units are susceptible to separate breakage and exchange with other broken ends. In Tradescantia microspores the change from chromosome breaks to chromatid breaks occurred 32 to 26 hr before metaphase, i.e., in late interphase. Summarized data on root cells of Vicia faba indicated that the transition from chromosome aberrations to chromatid aberrations extended through the middle third of interphase. Conclusive evidence that sub-chromatid aberrations can only be induced during prophase or other division stages was established. In Lilium, irradiation before late pachytene produced no increase in the subchromatid exchanges, but irradiation at later stages yielded increasing numbers until a period of highest sensitivity was reached at late diakinesis. From this stage on no other types of aberrations were induced that would produce a visible effect at the following anaphase. It was concluded that results from radiation breakage are reliable indications of reproduction. The mechanisms by which both chromosome and chromatid aberrations are produced are discussed. (BBB)

16314 RADIATION-INDUCED ASYNAPTIC MUTATIONS IN DURUM WHEAT (TRITICUM DURUM DESF). Martini, G.; Bozzini, A. (Univ., Pisa, Italy). Chromosoma, 20: 251-66 (1966).

The cytologic behavior and the inheritance of two asynaptic mutations obtained independently by neutron treatment of durum wheat seeds of varieties Cappelli and Aziziah are considered. Mutant individuals of both lines were morphologically normal but were completely sterile. Analysis of chromosome behavior at the several stages of pollen mother cell meiosis was accomplished in mutant progenies of both varieties during two subsequent generations. A completely random chromosome disjunction was found at anaphase I, together with multipolar spindle and laggard chromosomes. At meiotic second division a large number of abnormalities was found, as a consequence of previous asynapsis and irregular polarization. Some differences in cytologic behavior were found between the asynaptic mutants of variety Cappelli and the asynaptics of variety Aziziah. Genetic analysis demonstrated that both mutations behaved as monogenic recessives. (BBB)

16315 MACROMOLECULAR SYNTHESIS IN A THYMINE-REQUIRING BACTERIUM AFTER ULTRAVIOLET IRRADIATION. Hanawalt, P. C. (Univ. of Copenhagen). pp 305-7 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

Quantitative studies were made on the effects of uv light on colony formation, protein synthesis, and RNA and DNA synthesis in Escherichia coli 15T. Studies were also conducted in the triple mutant, E. coli 15T-A-U-, that requires thymine, arginine, and uracil. Protein synthesis, ^{35}S incorporation, exhibited the same sensitivity to uv in an exponentially growing culture of E. coli 15T-A-U- as in a culture which had received the 90-min preincubation +T-A-U prior to irradiation. The changes which occurred during the preincubation period apparently did not affect quantitatively the ability of irradiated cells to synthesize protein after a given uv dose. Colony formation showed a very striking difference in sensitivity to uv after the preincubation +T-A-U. An exponentially growing culture exhibited the same characteristics as the parent strain. However, after 45 min preincubation +T-A-U, by which time 35% of the population was immune to thymineless death, a multiple-target type dose-effect curve was obtained with the same final exponential decay rate but at a multiplicity of 10. After the full 90-min preincubation, the multiplicity had increased to the order of 100. This decrease in sensitivity was considered to be due to the existence of a less labile state of DNA at some stage in its replication cycle. Transition to the resistant state was not a gradual one occurring throughout the growth cycle. The uv damage to DNA was thought to be due primarily to photons absorbed in associated RNA units, i.e., when the RNA is associated with the DNA, a hit in any unit is likely to inactivate some essential function and lead to inability to form a colony and when RNA units are dissociated there may be much duplication of the different functions, so a large number of ribosomes of a particular type must be inactivated in order to completely inactivate a particular essential function. It was suggested that the sensitivity for survival of bacterial colony formation was determined by the degree of association which exists between the RNA and DNA at the time of irradiation. (BBB)

16316 IRREGULAR TRANSMISSION OF A BLOOD-GROUP COMPLEX IN ONE FAMILY OF PIGS FOLLOWING IRRADIATION. Andersen, E. (Royal Veterinary and Agricultural Coll., Copenhagen). Vox Sang., 12: 25-31(1967).

A presumed radioinduced anomaly of inheritance affecting the E blood-group system was detected in one pig among 10,056 progeny from 1171 matings. Gonads of Hampshire and Duroc swine were exposed to a 300-R x radiation dose in order to study the effects of x radiation on the genetics of swine. Female parents were not irradiated but were descendents of exposed and unexposed males. The genetic consequences of the paternal irradiation were measured, in the first filial generation, on red cell antigens controlled by genes at 11 loci. In this study of mutations at these loci, the exceptional event discovered was an irregular transmission of a blood-group complex in the E system. An E^1E^3 Hampshire male was mated with an E^1E^1 Hampshire female. The male had been irradiated, while the genetic material of the female had not. Of 13 pigs born, 6 were E^1E^1, 6 were E^1E^3, and 1 was E^1E^2. About 10,000 gametes derived from parental males and females in both breeds were tested where an E gene mutation, if it had occurred, would have been detected. About 25% of these genes were derived from irradiated spermatogonia. Consequently, the estimate of the rate of spontaneous plus induced mutations at the E locus is 1 in 10,000, if the exceptional pig is regarded as a mutant. Problems of interpretation in the studies of mutation rates at specific loci are discussed. The genetic basis of a new trait cannot be unravelled without further breeding tests. The exceptional progeny was not available for inheritance studies; thus, the distinction of a point mutation from an interallelic recombination was not possible. (BBB)

16317 CYTOGENIC AND KARYOLOGICAL STUDIES OF CLINICALLY TREATED GYNECOLOGICAL TUMORS. Eicke, Jutta; Emminger, Adelheid; Strauss, C.; Mohr, U.; Wrba, H. (Univ., Munich). Z. Krebsforsch., 67: 205-12(1965). (In German).

Attempts were made to detect the effect of radiation and other agents on the chromosomes of cancer cells in vitro. Tumor cells of eight human ovarian carcinomas and of one cervical carcinoma with ascites were studied cytogenetically and karyologically after the patients were treated with hormones, cytostatic agents, and radiation. All of the patients had received Ra and x ray treatment in various doses. The stem cells of six of the tumors were in the diploid range of the chromosome numbers (37 to 46). In these six the distribution of the chromosome numbers and the percentage of polyploid cells were very different. Some tumors were studied several times but results obtained were not significant. Analyses of the karyogram of the stem cells of the various tumors showed characteristic displacements within the groups of chromosomes in gynecologic tumors. Results were statistically comparable. (BBB)

16318 RADIATION AND MUTATION IN FISH. Purdom, C. E. (Medical Research Council, Harwell, Eng.). pp 861-5 of STI-PUB-126.

The somatic effects of ionizing radiation on fish have been studied by several groups of research workers and the subject is becoming reasonably well documented. In general, it appears that fish show similar responses to mammals after effective radiation doses, but that much larger doses are required for fish than for mammals. Information on the genetic effects of ionizing radiation on fish is almost nonexistent, being restricted chiefly to embryonic-lethal effects of irradiated spermatozoa. The present study is an attempt to determine the genetic effect of radiation in fish in terms of the production of mutations. For this, use was made of the Cyprinodont Lebistes reticulatus, the genetics of which have been extensively studied in the laboratory. Two basic types of inheritance are found in Lebistes: (a) normal recessive type inheritance affecting, in particular, general body colour, and (b) sex-linked and/or sex-limited dominant male colour-pattern inheritance – this may also be observed in females treated with male sex hormones. Mutation of factors of type (b) may be observed in first offspring. Similarly, mutation of type (a) can be detected in the F_1 if use is made of a "specific-locus" technique. Mutations of spontaneous origin of both types have been observed in laboratory stocks and in preliminary studies with x-rays. Present data suggest that spermatozoa of Lebistes are much less sensitive than spermatozoa of the mouse to the mutagenic effects of ionizing radiation. (auth)

16319 LOW-LEVEL CHRONIC IRRADIATION OF SALMON EGGS AND ALEVINS. Bonham, K.; Donaldson, L. R. (Univ. of Washington, Seattle). pp 869-83 of STI-PUB-126.

Chinook and coho salmon eggs were subjected to about 0.5 R/d of gamma radiation from cobalt-60 from shortly after fertilization until the alevins swam, resulting in a total dose of about 40 R.

Irradiated fish were compared to similarly treated controls regarding survival, growth, vertebral numbers and anomalies, other defects and sex ratios. The juveniles, marked for identification, migrated to the ocean, whence some returned to the place of their liberation to spawn, 2, 3, 4, or 5 yr after their conception. Precocious chinook males, comprising the 2-yr group, were mated with mature females not previously involved in the experiment, to test irradiation effects on males only. The resulting eggs were not irradiated, but the young fish were marked and liberated. The offspring of the 3-yr group of chinooks were reared, marked, and released without being irradiated, to test irradiating only the first generation. Offspring of the 4-yr chinooks were reirradiated, thus more nearly simulating the reirradiation to which naturally spawning salmon would be subjected in a stream bearing radionuclides. Among both chinook and coho salmon, survival and growth of the young of the first generation tended not to be markedly affected by this level of radiation, but certain abnormalities were usually more numerous in the irradiated than in the control stock. Total number of returning spawners and egg production per female from the irradiated groups usually exceeded those of the controls. At 2.5 times the previous radiation level or 1.3 R per day, the survival, growth, and occurrence of abnormalities in juveniles showed no significant difference between controls and experimentals. (auth)

16320 PHYSIOLOGICAL STUDIES OF ECHINOIDEA DEVELOPMENT. DISTURBANCE OF THE MICROMERE BY UV IRRADIATION. A CONTRIBUTION TO THE PROBLEM OF INDUCTION AND REGULATION. Czihak, Gerhard (Max-Planck-Institut fuer Meeresbiologie, Tuebingen, Ger.). Arch. Entwicklungsmech. Organ., 157: 199-211(June 1966). (In German).

Ova of Psammechinus miliarus were grown to the 16-cell stage and exposed to uv irradiation. The micromeres were irradiated either during the interval between the anaphase and the telophase or during the long interphase, or division of the blastomere. The size of the radiation field corresponded to the size of the nucleus. The nuclei were irradiated singly for periods of 30 to 50 sec, and in part laterally 2 at a time for 60 to 100 sec. During division of the micromeres the chromosomes were irradiated in sequence 3 or 4 times for 10 or 15 sec to prevent any micromere from developing too much during the irradiation. The formation of the primary intestinal tract was delayed to varying degrees but never completely prevented. Since the macromeres may possess regulatory properties the assumption that intestinal induction may be caused by micromeres could not be excluded. After uv irradiation the primary mesenchymal cells which are normally formed by the micromeres are absent for a longer time, and are formed later, probably by regulation from the secondary mesenchymal cells. (BBB)

16321 CHROMOSOMES IN POLYCYTHAEMIA VERA. Kay, H. E. M.; Lawler, Sylvia D.; Millard, Rosemary E. (Royal Marsden Hospital, London). Brit. J. Haematol., 12: 507-28 (Sept. 1966).

The effects of ^{32}P on the chromosomes of bone marrow cells were analyzed in 43 cases of polycythemia vera. Out of 11 untreated cases there was aneuploidy of some cells in 4 cases and of all cells in 3 cases. In the latter a partial reversion to euploidy followed ^{32}P treatment. In 32 cases treated by ^{32}P, all the analyzed cells were normal in 9; there were sporadic abnormalities in 12; clones of abnormal cells were detected in 8; and in 3 cases with leukemia or a leukemoid state there was a variety of abnormalities. The commonest derangements were deletions and translocations. Unstable abnormalities such as acentric fragments were rare. In 4 out of the 8 cases with abnormal clones, the abnormality was an apparent deletion of an F-group chromosome; a similar cell was observed in an untreated case. The significance of the F-group abnormality is discussed. The chromosome abnormalities were also considered in relation to the etiology of the disease, to its duration and treatment, its manifestations and complications, and to the chromosomal abnormalities found in the blood lymphocytes. (BBB)

16322 ORIGIN OF COMPLETE AND MOSAIC MUTANTS FROM MUTAGENIC TREATMENT OF SINGLE CELLS. Nasim, Anwar; Auerbach, C. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 4: 1-14(Feb. 1967).

A system of colour mutation in Schizosaccharomyces pombe was used for testing current theories on the production of complete (non-sectored) mutations by mutagenic treatment of uninucleate cells. Cells of the purple adn-7 strain were exposed to UV, ethyl methane sulphonate, N-methyl-N'-nitro-N-nitrosoguanidine and hydroxylamine and the frequencies of complete and mosaic forward mutations were scored at 5 antecendent loci in the adenine pathway, all of which yield white mutant cells. At equivalent values of survival or overall mutation frequency, the mutants produced by the various mutagens included different proportions of mosaics, ranging from about 90% for HA to from 13 to 48% for UV; EMS and NMG gave intermediate values, similar to those previously found for HNO_2. There was no overlap in the range of mosaic production between HA and UV, and very little overlap between the other chemicals and HA on the one hand, UV on the other. While nitrous acid has been shown to produce the same proportion of mosaics over a wide range of doses, the mutagens used in the present study yielded increasingly lower proportions of mosaics with increasing dose. Qualitatively, this trend would be expected if completes originated from mosaics in which the complementary strand had suffered a lethal hit, but quantitatively the decrease was much too small to fit this hypothesis. The results are incompatible with 2 of the existing hypotheses: the master-strand hypothesis of DNA replication and the lethal-hit hypothesis mentioned above. They are compatible with the 2 remaining hypotheses, one of which postulates that complete and mosaic mutations arise by different molecular mechanisms, while the other assumes that mosaics are transformed into completes through repair of mismatched bases. Expected consequences of these hypotheses are open to tests, and suggestions for such tests have been put forward. (auth)

16323 QUANTITATIVE AND QUALITATIVE ASPECTS OF PHOTOREACTIVATION OF PREMUTATIONAL ULTRAVIOLET DAMAGE AT THE ad-$_3$ LOCI OF NEUROSPORA CRASSA. Kilbey, B. J.; de Serres, F. J. (Oak Ridge National Lab., Tenn.). Mutat. Res., 4: 21-9(Feb. 1967). (ORNL-P-2133).

Experiments have been carried out to determine whether photoreactivation is specific for a particular fraction of the UV-induced premutational damage leading to ad-$_3$B mutants in Neurospora. Populations of mutants were compared which had been induced by UV in the presence and absence of photoreactivation. In spite of the reduction in mutation frequency brought about by photoreactivation, no evidence was found to suggest that any part of the mutant population was repaired preferentially. The simplest interpretation of this result is that there is but one type of premutational lesion induced by UV in this system. Repair of a fraction of this damage should affect all types of mutants similarly. Alternatively, if more than one type of premutational lesion exist, some of which are nonphotoreactivable, it is necessary to assume that, in terms of the mutants they are capable of producing, the photoreactivable and nonphotoreactivable lesions are equivalent. (auth)

16324 COMPARISON OF MUTAGENESIS OF X-RAYS AND TRIETHYLENE MELAMINE IN PARAMECIUM, WITH EMPHASIS ON THE ROLE OF MITOSIS. Kimball, R. F.; Perdue, Stella W. (Oak Ridge National Lab., Tenn.). Mutat. Res., 4: 37-50(Feb. 1967). (ORNL-P-2118).

The effect of mitosis on the mutation processes initiated in Paramecium aurelia by the alkylating agent triethylene melamine (TEM) and by x rays was investigated by treating synchronized groups of cells with the mutagen at closely spaced intervals throughout the latter part of the cell cycle; by determining the effect of an intervening cell division on the reduction of mutation yield caused by treatment with streptomycin; and, in the case of x rays, by determining the effect of dose rate on cells irradiated in midmitosis. The results suggest that TEM induces a single kind of premutational damage that is repaired at an essentially constant rate throughout the cell cycle, including mitosis, and is fixed as final mutation at the time of DNA synthesis but not at any other time. Some mutation may also be produced by processes independent of DNA synthesis, but if so, their contribution to the overall yield is quite small. The x ray results are more complex. Some premutational damage induced during midmitosis remains reparable into the next G_1 period, but there is suggestive evidence that some is converted to an irreparable form during mitosis. There is also some evidence that the rate of repair, even of that premutational damage that can only be fixed at DNA synthesis, can vary during the cell cycle. Whether or not any mutation is fixed at mitosis, an appreciable fraction of the x ray-induced mutations arise by fixation independently of DNA synthesis. The likelihood of this kind of fixation varies widely during the cell cycle. Thus mutagenesis by x rays appears to be more complex than that by TEM, though the two have in common that a considerable fraction of the mutations arise from initially reparable premutational damage that is fixed at DNA synthesis. (auth)

16325 VIABILITY OF HETEROZYGOTES FOR INDUCED MUTATIONS IN DROSOPHILA MELANOGASTER. III. MUTATIONS IN SPERMATOGONIA. Falk, Raphael (Hebrew Univ., Jerusalem). Mutat. Res., 4: 59-72(Feb. 1967).

A random array of mutations was obtained by irradiating Drosophila melanogaster with x rays. Irradiation was given in 1, 2 and 4 instalments of 4000 R each. Only chromosomes irradiated in spermatogonial stages were sampled. There was a significant increase in the mean viability coefficient of heterozygotes for the series of chromosomes irradiated with 6000 and 12000 R. In these

2 series many mutations were induced which drastically reduced the viability of the homozygotes: only about 20% of the homozygotes for chromosomes irradiated with 12000 R were in the normal range. On the other hand, the number of flies heterozygous for the irradiated chromosomes in tests designed to determine viability of homozygotes indicated that the induced detrimental mutations were not completely recessive. The contrast between the findings in the 2 parts of the experiments is considered in relation with the current hypotheses on the effect of induced mutations on viability. Since the genetic background of the flies was highly heterozygous even before irradiation the viability of the heterozygotes for induced mutations was expected to decrease according to all current hypotheses. Probably the increased viability coefficients were biased by factors other than viability, but it would be premature to suggest at this stage a hypothesis that explains all the findings satisfactorily. (auth)

16326 MUTATIONS FOR THE MONOGERM SEED CHARACTER IN BEET INDUCED BY POLLEN IRRADIATION. Joergensen, J. Helms; Jensen, C. J. (Danish Atomic Energy Commission Research Establishment, Risoe, Roskilde). Kongel. Vet. Landbohoejskole, Arsskr., 226-33(1966).

Mature pollen of a Danish multigerm, red-colored beet variety was γ irradiated (20, 30, 40 krad) and used to pollinate monogerm, white-colored beets. Among 12,158 flowering hybrid F_1 plants that all had the red color of the male parents, 40 monogerm plants were found. Of the 40 monogerm hybrids, 35 showed a uniformly deep red color of the root and had either wholly green or red-striped flower branches, and 5 showed a paler red. These five plants are considered to be hybrids because of the presence of the red color. The highest frequency (0.37%) of monogerm hybrids was observed after a dose of 20,000 rad, while a considerably lower frequency (0.07%) was found after 30,000 rad. The F_2 material originating from the three female plants pollinated with non-irradiated pollen showed a segregation frequency of monogerm plants strongly deviating from the expected value of 25%. In segregation frequency of monogerm plants all three F_2 populations differ significantly from the mean frequency of 3.1%. Possibilities as to the origin of these monogerm plants are discussed. It is concluded that the dominant gene of the pollen parent conditioning multigermness was induced to mutate by the pollen irradiation treatment. The irregular segregation ratios must be ascribed to the presence of genetic modifiers either in the female or in both parents, or to a reduced transmission of the m-gene through the gametes. (BBB)

16327 ROLE OF GENETIC FACTORS IN THE AGING PROCESS. Curtis, Howard J.; Tilley, John; Crowley, Cathryn; Fuller, Martha (Brookhaven National Lab., Upton, N. Y.). J. Gerontol., 21: 365-8(July 1966). (BNL-10006).

Chromosomal aberrations develop in liver cells as a function of the age of the animal. Ionizing radiation, which produces an effect in animals closely resembling premature aging, also increases chromosomal aberrations, and the increase is proportional to the life shortening. For inbred strains of mice which live quite different life-spans but which die from a variety of degenerative diseases, the rate at which aberrations develop is roughly inversely proportional to the life expectancy. A study of the development of chromosomal aberrations with age in regenerating liver cells in three different strains of mice showed that in the C58 strain, which develops a fatal leukemia at about 300 days of age and is thus short-lived, aberrations develop as slowly as in long-lived strains. Hybrids developed chromosomal aberrations at a rate between that of the two parent strains, but their longevity resembled that of the long-lived parent. These experiments demonstrate that the simple mutation concept of aging will not explain all the known facts and must be modified. The hybrid experiments indicate that there are specific genetic characters which control chromosomal stability, which in turn are partly responsible for initiating the aging process. Chromosomal stability has two components: an inherent stability of the chromosomal structure, and an active repair process which will restore chromosomes to normal following damage, provided the damage is not too extensive. For example, much damage caused by low doses of γ rays can be repaired in a cell provided it does not undergo cell division, but any dose of neutrons which produces large chromosomal breaks causes permanent chromosomal damage. (BBB)

16328 LEAF TIP HOODING: AN INDUCED MUTATION IN N. TABACUM, VAR. DELCREST. Gopinath, D. M.; Krishnamurthy, K. V. (Central Tobacco Research Inst., Rajahmundry, India). Genetica, 37: 93-6(1966).

A leaf tip hooded mutant of the variety Delcrest occurred in the progenies of seeds treated with neutron irradiation at $2.5 \times 10^{12} N/cm^2/sec$. Associated with the leaf tip hooded character were other clearly discernible features such as gigas nature of the plant, longer leaves, closer arrangement of leaves, and delayed flowering. Whether these associated characters could be due to pleiotropism was examined, and evidence for this was found. Flowering in the mutant was delayed 12 days. The mutant bred true for all the associated characters, as tested for over 4 generations. Reciprocal hybrids with normal plants were identical, revealing no cytoplasmic interference. The characters of F_1 plants were mostly those of the parent; plant height and flowering were intermediate; and hooding of the leaf tip was absent. Cytology of mutant, parent, and hybrid revealed no disharmony, and all 3 were fertile. When the reciprocal F_1's were selfed and reciprocally intercrossed, yielding 4 F_2 families, the pooled segregation was 231 normal vs 88 hooded. When the reciprocal F_1's were also reciprocally backcrossed to the mutant, the 4 back-crosses jointly gave 116 normal vs 139 hooded. These ratios confirm that the mutant is a monogenic recessive. (BBB)

16329 ANALYSIS OF THE GENETIC SENSITIVITY TO X RAYS IN FEMALE DROSOPHILA MELANOGASTER. Morey, M. (Centro de Investigaciones Biologicas, Madrid). Genet. Iberica, 17: 1-68(1965). (In Spanish).

Ovaries of Drosophilia of various ages were examined to determine the distribution of oocytes in various stages of oogenesis. After x irradiation of female flies with 690-R doses, the frequency of lethals in the ova and degree of fertility were examined. In other experiments doses of 1800 R were given and dominant lethals in the embryos were evaluated. To obtain information of the x-ray dose that causes death in the oocyte, females of different ages were irradiated with doses of 4390 R. The results indicated that the concept of germinal selection in oogonia for dominant lethals must be modified by the finding that not all oogonia affected by lethals are replaced by unaffected oogonia. Thus, the frequency of dominant lethals in oogonia is higher in irradiated females than in nonirradiated controls, and this frequency increases with the dose used. On the basis of the observed sensitivity for dominant lethals, the proportion of lethals in the embryo phase, and germ cell mortality, an explanation for selection in oogonia is proposed. It was found that even though an oocyte is killed by irradiation, the germinal follicle may continue to develop and carry on vitellogenesis. The follicle may be resorbed or vitellogenesis may proceed to its late states; then the processes normally seen in the mature oocyte either do not take place or do so in a deranged way. In the early stage of formation, follicles are especially radiosensitive, and normal fertility in irradiated female Drosophila is not regained until eggs are laid which originated from the early oogonia in the irradiated ovary. (BBB)

16330 THE BROOD PATTERN OF X-RAY INDUCED CROSSING-OVERS IN DROSOPHILA MELANOGASTER MALES. Puro, Jaakko (Univ. of Turku, Finland). Proc. Int. Congr. Genet., 11th, The Hague, 1963, 69[1964].

The pattern of induced crossing-overs in the male flies was studied using a hybrid stock of 12 recessive markers in the third chromosome. Adult males, after treatment with 3000 R of x rays, were mated singly and sequentially (at 2- or 3-day intervals for the first 3 broods and daily from the 7th to the 24th day) to females of an appropriate genotype for detecting crossovers. Fertility and fecundity of the treated males, after decreasing to the lowest level on day 8, had a marked recovery on day 10 followed by a small depression on days 11 and 12. No difference between the experimentals and controls were found for any of the rest of the broods. The number of tested F_1 offspring totaled 51,964 from 46 treated and 25,778 from 11 control males. With rare exceptions, proven crossovers were first detected on the 9th day but the highest incidence was on the 10th day after treatment. Clusters of crossovers, many of which continued in several broods, began on the 11th or 12th day. The evidence from the continuing crossover clusters substantiates the previous hypothesis, proposed on the basis of results from clusters of recessive third-chromosome lethals, that the treated predefinitive gonia (on an average 5 in number per male, based on the size of clusters) are responsible for the recovery of sperm production to the control level by the 12th day. Furthermore, it appears that the high incidence of crossovers on the 10th day is the result of induction of crossovers in definitive (secondary) gonia. (BBB)

16331 CHEMISTRY OF CHROMOSOME CONTINUITY. Wolff, Sheldon (Oak Ridge National Lab., Tenn.). Nat. Cancer Inst. Monogr., No. 18, 155-79(Dec. 1965).

Three kinds of experiments that have given some information about chromosome structure are described. One type of experiment on the metabolic requirements for the rejoining of radiation-induced breaks can be interpreted as indicating that protein contributes to the linear continuity of the chromosome. A second type of experiment on the type of chromosome aberrations induced by radiation indicates that the chromosome is multistranded. A third type of experiment on enzyme digestion of isolated fixed Vicia faba chromosomes has indicated that the mitotic chromo-

some depends upon protein for its linear continuity and is multi-stranded. X-ray dose fractionation experiments performed on 2-break chromosome aberrations such as dicentrics and rings revealed 2-hit dose kinetics, that is, they increased as the square of the dose. If the dose was fractionated into 2 parts such that the breaks from the first dose cannot rejoin or restitute (rejoin in the original configuration) before the breaks from the second dose are introduced, then both groups of breaks were present concurrently and capable of rejoining with one another to form 2-break aberrations. In experiments on G_1 cells in root tips of soaked seed of V. faba, the 2-dose fractions were separated by enough time to allow rejoining of the first group of breaks. It was found that after the first dose was administered it was possible to inhibit metabolism in such a way that breaks would remain open instead of restituting, and that cellular respiration and the production of adenosine triphosphate were necessary for breaks to close. The results obtained with V. faba chromosomes, in general, seemed to fit those obtained with many other organisms, the one major exception being the results obtained on lamp-brush chromosomes of the newt. (BBB)

16332 GENETICAL ANALYSIS OF PROLINE MUTANTS AND THEIR SUPPRESSORS IN ASPERGILLUS NIDULANS. **Weglenski, P. (Warsaw Univ.). Genet. Res., 8: 311-21(Dec. 1966).**

Three of the 13 proline mutants studied (pro-13, pro-14, and pro-16) were obtained after uv treatment of a strain carrying bi-1; w-3; fr-1. Complementation between these proline auxotrophs was studied. Two groups of mutants with different complementation pattern were found. These 2 groups could also be distinguished on the basis of recombination tests. The spontaneous reversion rate of proline mutants was established. In all cases studied the reversions were due to suppressor mutations. Dominant, semidominant, and recessive suppressors were distinguished. When complementation between recessive suppressors was studied, only a few of the suppressors obtained could be located in different complementation groups. Three suppressor loci were mapped, 2 of them, su-2 and su-6, in chromosome III linked to the phen-2 locus, respectively 22 and 26 map units distant, and the third in chromosome I, linked to the ad-9 locus (1.9 map units). Mutation in su-2 occurred at the su-4 pro locus. The action of these suppressors is thought to consist in affecting the pathway of arginine synthesis by 1 of 3 mechanisms: accumulation of an intermediate (ornithine); increased activity of ornithine δ-transaminase; or a third, as yet, unclear process possibly involving feed-back regulation of arginine synthesis or the regulation of arginine breakdown to ornithine. (BBB)

16333 MITOTIC EFFECTS OF MONOCHROMATIC ULTRAVIOLET IRRADIATION OF THE NUCLEOLUS. **Carlson, J. Gordon; Gaulden, Mary Esther; Jagger, John (Oak Ridge National Lab., Tenn.). pp 251-3 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (ed.). Amsterdam, Elsevier, 1961.**

Intense irradiation of 1 of the 2 nucleoli of the grasshopper neuroblast with a microbeam of uv radiation inhibits mitosis. Using a high-pressure mercury arc lamp, with filters to remove most of the intense ir, visible, and near-uv radiation, it was found that a 3-sec exposure (0.03 erg/μ^2) of 1 nucleolus to a microbeam 3 μ in dia permanently stopped mitosis when the cell was in any stage from late telophase through the first half of middle prophase. During the second half of middle prophase the cell became gradually less affected by irradiation of a nucleolus and by late prophase was completely insensitive to it. Microbeam irradiation of a nonnucleolar region of the nucleus caused some delay but the cell usually divided within 24 hr. Effects at each mitotic stage and for wavelengths 2650 and 2804 Å were studied in detail. For all of the mitotic stages studied prior to early prophase, 2650 Å was more effective than 2804 Å in retarding mitosis. In early prophase, however, there was overlapping of the 70% confidence limits, and middle prophase showed no difference in the efficiencies of the 2 wavelengths. This suggests either a gradual loss of RNA sensitivity or RNA effectiveness in altering the mitotic rate as prophase progresses. The neuroblast was most sensitive mitotically to 2650 Å and 2804 Å at middle telophase and very early prophase. Both stages were characterized by striking changes within the nucleus. Experiments, in which the time required by each irradiated cell to reach metaphase was compared with a median time determined from all the control cells, indicated that a small dose of uv radiation given to a nucleolus might stimulate rather than retard mitosis. It appeared that the protein rather than the RNA is the effective component of the nucleolus in producing uv-induced acceleration of mitosis. (BBB)

16334 MUTATION IN POPULATION. **Proceedings of a Symposium on the Mutational Process Held in Prague in August 9–11, 1965. Honcariv, Robert (ed.). Prague, Czechoslovak Academy of Sciences, 1966. 193p. (CONF-650814-Vol.1).**

Twenty-eight papers are included on animal population genetics, environmental effects on genetic processes, plant genetics, and genetic defects in human populations. A separate abstract was prepared for one paper. (M.M.B.)

For an abstract of the individual paper see: 16520.

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Refer also to abstracts 15995, 16142, 16197, 16410, 16428, 16836, and 17483.

16335 (CMN-Pub-4/65(Vol.1)) MANUAL DE HIGIENE DAS RADIACOES E PROTECAO RADIOLOGICA. (Manual of Radiation Hygiene and Biological Protection). **Bitelli, Thomaz (Sao Paulo Univ. (Brazil). Centro de Medicina Nuclear). 1965. 185p. (In Portuguese). DTIE.**

A manual of radiation hygiene and radiological protection written for radiologists, scientists, and technicians using radioisotopes or x rays in medical, physical, chemical, or industrial areas is presented. In the first volume the types of radiation and the fundamentals of radioactivity are outlined. The radiation units are defined. The interaction of radiation with living cells is described in some detail. The design of laboratories using radioisotopes is considered. The detection of radioisotopes and the dilution of radioactive liquids are also considered. (J.S.R.)

16336 (DPST-67-30-1) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, July–December 1966. **(Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Contract AT(07-2)-1. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.**

Results of the environmental monitoring program of the atmosphere, vegetation, and food, and water for the period extending from July 1 through December 31, 1966 are presented. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by worldwide fallout from nuclear weapons testing. Fallout from the Chinese nuclear test on October 27, 1966, was detected at SRP. Fallout from the 5th Chinese nuclear detonation in late December had not arrived at SRP by December 31st. Beta activity in air, which showed no relationship with plant operations, was about the same as that observed for the past 18 months. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of radionuclides in river water at Highway 301 did not exceed 1.2% of the Maximum Permissible Concentrations. (auth)

16337 (KAPL-M-6592) DOSE B: A CDC 6600 PROGRAM FOR CALCULATION OF INHALATION AND EXTERNAL DOSE FOR ESTABLISHING REACTOR SITING DISTANCE REQUIREMENTS. **Ellison, T. W.; Dunham, A. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 16, 1967. Contract W-31-109-eng-52. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.**

The Dose B Program has been written to facilitate the calculation of distance factors for nuclear reactor sites as described in the well known USAEC Document "Calculation of Distance Factors for Power and Test Reactor Sites," TID-14844. The calculations are essentially as described in this document except that the dose code allows for arbitrary operating power histories and variable containment leak rates. The program calculates the thyroid and direct gamma doses received by an individual standing at a distance D from the point of fission product release for a time TAU subsequent to the time of release and based upon a given reactor operating history. (auth)

16338 (N-66-26692) RADIATION MONITORING WITH NUCLEAR EMULSIONS ON PROJECT GEMINI. I. EXPERIMENTAL DESIGN AND EVALUATION PROCEDURES: PARTIAL RESULTS ON MISSIONS 4 AND 5. **Schaefer, Herman J.; Sullivan, Jeremiah J. (Naval School of Aviation Medicine, Pensacola, Fla.). Feb. 18, 1966. 17p. (NASA-CR-75036; NAMI-955). CFSTI $3.00 cy, $0.65 mn.**

On Gemini 4 and 5, small packs of nuclear emulsions combined with other radiation sensors to flat pliable units were worn by the astronauts inside their space suits. Track and grain counting of 200 micra Ilford G.5 and K.2 emulsion pairs in the packs furnished the particle and energy spectrum of the radiation incident upon the astronaut's body. Evaluation of flux and energy spectrum in terms of millirad dose showed that the bulk of the exposure was due to trapped protons picked up in the South Atlantic Anomaly. The energy spectrum of the proton flux within the ship on the body of the astronaut is a continuum extending from zero to about 300 MeV, with a broad, well-developed maximum in the 30 to 40 MeV region. Since a large part of the flux is of low penetrating power, the radiation level within the capsule depends on local shield ge-

ometry and shows dose rate variations at different locations of at least 60%. Representative total doses were 48 millirads on Gemini 4 and 105 millirads on Gemini 5. (STAR)

16339 (NP–16327) LASER SYSTEMS: CODE OF PRACTICE. 1965 Edition. Weston, B. A. (Ministry of Aviation, London (England)). Nov. 1965. 32p. Dep. mn.

A code of practice for regulating the entire range of activities in which lasers are involved is outlined. Principles and methods of protection from laser radiation for personnel are presented. The nature of radiation injuries that may occur in the eyes of personnel using lasers is discussed. Based on mathematical calculations, the maximum permissible exposure doses of personnel to laser radiation are designated in the code. General rules for personnel to follow in laser restricted areas and the duties of an appointed officer-in-charge are outlined. Criteria for safety spectacles of known adequate performance and for medical supervision of personnel are set forth. (B.H.S.)

16340 (RISO–131) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1965. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1966. 23p. Dep. mn.

Fallout radioactivity was measured in the Faeroes in 1965. Strontium-90 and ^{137}Cs were determined in regularly collected samples of precipitation, milk, potatoes, sheep, fish, drinking water, and deciduous teeth. In addition, analyses of spot samples of grass, soil, sea water, sea plants, birds, vegetables, bread, cheese, and eggs were carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faeroes in 1965 are given. (auth)

16341 (SCL-DC–67-5) HAZARDOUS MATERIALS HANDLING FACILITY. Calder, C.; Campbell, R. O. (Sandia Corp., Livermore, Calif.). Feb. 1967. Contract AT(29-1)-789. 16p. (CONF-670204-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 84th Conference on Methods in Air Pollution and Industrial Hygiene Studies, Oakland, Calif.

A centralized facility for both wet and dry operations with hazardous materials at atomic research facilities is described in which: personnel exposure to hazards is greatly reduced; wet effluent is confined and contained; holding tank agitation provides reliable representative sampling; dry contaminants are enclosed and captured; simplified HEPA filter mounting and sealing system decreases handling and disposal problems; operational procedures may be standardized, thus yielding improvements in both administrative and material control; and supervisory requirements are minimized. Experience with both the wet and dry operations has demonstrated that the personnel protective features function as intended, and basic changes are unnecessary. (auth)

16342 (UCLA–12-615) ENVIRONMENTAL CONTAMINATION FROM A NUCLEAR REACTOR AT THE NEVADA TEST SITE. Mork, Harold M.; Berta, Firmin J. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Dec. 1966. Contract AT(04-1)-Gen-12. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

After the test of the Kiwi-A reactor on July 1, 1959, the environmental contamination from the effluent was assessed. The fallout pattern was very narrow and extended on an approximate bearing of 350 degrees from the test cell. The maximum level of contamination (16.2 $\mu c/ft^2$ at H + 12 hrs) was measured at approximately 1.5 miles. The total activity associated with the smaller size fractions increased significantly, and there was a corresponding decrease in the activity of the larger size fractions with increase in distance from the test cell. The β radiation decay slopes deviated appreciably more from the $T^{-1.2}$ decay expression than previously observed slopes of fallout materials collected from weapons test activities. This variability indicated fractionation. The distribution of radionuclides was extremely variable at the several stations. The ^{140}Ba, ^{99}Mo, ^{103}Ru and $^{95}Zr-^{95}Nb$ nuclides were detected at all stations; ^{141}Ce, ^{144}Ce and ^{106}Ru were generally present only at the closer stations; and ^{131}I, ^{91}Y and ^{137}Cs were represented only at the more distant locations. No levels of airborne fission product activity above normal background were detected at locations sampled 4 to 8 miles NE of the test cell. The less than 44 micron size fraction was slightly more soluble in water and somewhat less soluble in 0.1 N HCl than the greater than 44 micron size fraction. The solubilities ranged from less than 1 to about 5 percent for water, and from about 8 to 24 percent for dilute acid. The levels of radioactivity observed after the Kiwi-A test were much less than those observed following weapons tests; however, the data suggested that a larger percentage of the radioactive debris from Kiwi-A than from weapons tests was available to the biological indicators, the native rodents and jackrabbits. (auth)

16343 (JPRS–38272, pp 123) EVALUATION OF THE RADIATION IN A FLIGHT TO THE MOON. Vikhrov, A. I.; Dudkin, V. E.; Kovalev, E. E.; Kuznetsov, V. G.; Smirennyi, L. N. Translated from pp 99-100 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The radiation dose to astronauts during a flight to the moon was calculated. It is pointed out that radiation exposure will occur from emissions from the radiation belts around the earth, from galactic space radiations, from solar flares, and from radioactive rock on the moon. Calculations showed that the time for crossing the Van Allen radiation belts will be about 30 min and will result in average tissue dose that will not exceed 3 to 5 Rem; the dose from galactic space radiation will be about 4 to 8 Rem during a 30-day flight. The greatest danger will be from radiation from solar flares, the probability of which will be about 10% during a 30-day period of maximum solar activity. Behind a shield of 1 gram/cm^2 the surface dose can reach about 10^4 Rem from a high intensity flare, but this can be reduced to 50 Rem or less in a radiation shelter with proper shielding. (C.H.)

16344 (JPRS–38272, pp 124) THE PRINCIPLES OF CALCULATING PROTECTION FROM SPACE RADIATION. Vikhrov, A. I.; Dudkin, V. E.; Kovalev, E. E.; Kuznetsov, V. G.; Kolomenskii, A. V.; Smirennyi, L. N. Translated from pp 100 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Problems involved in calculating the radiation protection requirements of astronauts while achieving a minimum increase in weight of the spaceship are discussed. Results are included of calculations of the radiation dose from the Van Allen radiation belts, calculations of average tissue doses of monoenergetic streams of protons of various energies, and calculations of the spectra of protons of solar flares. Based on these data examples are given of calculations of protection for certain flight trajectories of spaceships. (C.H.)

16345 (JPRS–38272, pp 173-4) RADIATION SAFETY FOR SPACE FLIGHTS. Grigor'ev, Yu. G.; Kovalev, E. E. Translated from pp 137-8 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The complex radiation exposure of astronauts during space flights is reviewed. It is pointed out that factors such as prolonged weightlessness, changes in the composition of the gaseous environment, the temperature in the cabin of the spaceship, the nature of the feeding and daily routine, and the psychic tension of the astronauts may influence the response to radiation exposure. It is concluded that a system of radiation safety for astronauts should include general protection of all compartments of the spaceship, a radiation shelter, and means for local protection; provisions for radiation dosimetry of the environment, individual dosimetric control, and signal and warning devices; provisions for chemical prophylaxis and therapy of radiation injury; and a ground-support radiation safety service. (C.H.)

16346 (JPRS–38272, pp 172) EVALUATING THE DANGER AND ESTABLISHING THE ALLOWABLE DOSES OF IONIZING RADIATION FOR ASTRONAUTS ON A FLIGHT TO THE MOON. Grigor'ev, Yu. G.; Domshlak, M. P.; Darenskaya, N. G.; Rayevskaya, S. A. Translated from pp 136 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Allowable radiation doses to astronauts during a flight to the moon were established on the basis of results of studies of radiation injuries in large laboratory animals exposed to doses of γ and proton radiation that are expected to be encountered during the flight. The results of clinical observations on patients exposed to γ and x radiation for therapeutic purposes were also used in evaluating the danger of radiation in space. (C.H.)

16347 (JPRS–38272, pp 306-7) EXPERIMENTAL INVESTIGATION OF THE EFFECTIVENESS OF LOCAL PROTECTION. Kuzin, R. A.; Nevskaya, G. F.; Popov, V. I.; Sychkov, M. A.; Shafirkin, A. V.; Yurgov, V. V.; Abramova, G. M.; Ginsburg, E. V.; Kalandarova, M. P. Translated from pp 236-7 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

A procedure is described that was developed for use in studies on the effects of local protection for animals against monoenergetic protons with energies from 100 to 600 MeV. Preliminary dosimetry measurements were made in a water phantom and the method of irradiation was developed using a heterogeneous bone-paraffin phantom. Animals were exposed from two sides to equalize the dose distribution. Paraffin was selected as the material for local protection. Results showed that paraffin reduced the tissue dose by 10 to 15 times. (C.H.)

16348 (JPRS–38272, pp 304-5) A METHOD OF IRRADIATING BIOLOGICAL OBJECTS WITH A MULTIPLY CHARGED

ION ACCELERATOR. Kudryashov, E. I.; Marennyi, A. M.; Popov, V. I.; Portman, A. I.; Solyanov, B. I.; Sychkov, M. A. Translated from pp 234-6 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Procedures are described that were developed for use in the exposure of animal cells in tissue culture to beams of charged particles obtained from a cyclotron. A gold foil was used to scatter the heavy ions and decrease the flow of electrons. The geometry used for regulation of the irradiation field with respect to the intensity and the energy of the ions is described. The use of a special collimator consisting of a system of concentric liners also served to even the field of irradiation and decrease the dose received by the biological material. The dose absorbed by the biological material was calculated by the measurement of ionization losses in polyethylene. (C.H.)

16349 (JPRS-38849) RADIOACTIVITY OF SOME FORMS OF VEGETATION STUDIED IN THE CLUJ CITY AREA. Azabo, A.; Piciu, Doina. Translated from Stud. Cercet. Fiz., 17: 1-4 (1965). 5p. (TT-66-35273). CFSTI $3.00 cy, $0.65 mn.

Fission products from nuclear testing in air and water represented the source of contamination for various plants. Analyses were made to determine the content of radioisotopes in a variety of plants such as wheat, cabbage, carrots, and grass. Variations in radioactivity in the plants with time were also determined. Results are tabulated. It was found that there was a greater accumulation of radioactivity in carrots than in other plants. The same isotopes were found in various plant species. These were ^{90}Sr, ^{90}Y, ^{140}La, ^{140}Ba, ^{95}Zr, and ^{59}Fe. (H.L.W.)

16350 (ORNL-tr-1544) MEAN CORRECTION FACTORS OF ROENTGEN IN rad FOR COMPACT BONE AND MUSCLE TISSUE. Rakow, Adalbert. Translated for Oak Ridge National Lab., Tenn., from Strahlentherapie, 127: 538-49(1965). 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The mean conversion factor for converting the measured standard ion dose into an energy dose in bones depended upon irradiation conditions and phantom depth. An attempt was made to establish relationships between these values by the use of quantum energy distribution measurements. Water phantoms were employed. New mean conversion factors, $\bar{f}$, were computed for several irradiation conditions. A clear relationship seemed to exist between $\bar{f}$ and the HVL for the energy interval used. (auth)

16351 RISK INVOLVED WITH NUCLEAR ENERGY. Manstein, B. Vitalst. Zivilisationskr., 9: 244-6(1964). (In German).

Insufficient scientific evidence is available concerning chronic and late injuries due to irradiation, the complex biological behavior of the some 1200 radioisotopes in cells, tissues, and organisms, their manner of uptake, transport, and incorporation, the contamination of foodstuffs, water, and atmosphere and the chains of transfer between these media, the over-all toxicity of radioisotopes, and the permissible range of tolerance for radiation injury. The dangers associated with radioisotopes should not be minimized and biological studies with them should be maintained and expanded. The most sensitive and complex detection equipment are necessary to evaluate the true contamination that may be present in foodstuffs. From the viewpoint of fundamental biophysical research, careful and clear formulations to promote effective protection against radioactive materials, whether used in medical or industrial fields, are as yet unrealized. A summary of calculated data that relates to hazards that result from nuclear fission in the atmosphere or radioisotopes emitted from atomic plants has been published in the "Vitalstoff-Tabellarium." This represents an extensive survey of the total radioactive contamination of man's environment. Greater attention should be given to the facts contained in this survey when factors of safety are to be ascertained and evaluated. (BBB)

16352 IS THERE ANY PROTECTION AGAINST RADIOACTIVE CONTAMINATION? TRUTH AND LEGEND. Manstein, B. Vitalst. Zivilisationskr., 8: 166-70(1963). (In German).

Considering that the problem of radioactivity contamination is worldwide it really cannot be measured adequately and evaluated properly. At present, measurements are insufficient to properly evaluate the variety of soil conditions and types of foods and eating habits of world populations that affect radioactive contamination. One of the most serious hazards is the variety of hot fallout particles that are present one week after an atomic explosion. This consists of a mixture of ^{99}Mo, ^{103}Rh, ^{132}Te, ^{132}I, ^{140}La, ^{141}Ce, and ^{143}Nd in particles with an average dia of 4 μ, that are readily deposited in lung spaces. The irradiation produced can range from a few hundred to 1000 R, causing destruction of cells and possibly cancer. Another major hazard is the production of large quantities of ^{14}C with which the possibilities of genetic and hereditary changes are possibly associated. This hazard is not limited to the present generation, but could extend through tens of following generations. Unfortunately, the measures that have been suggested for protection against these hazards are of relatively little practical value. For this reason there are no recommendations that would provide for even minor prospects of success in this regard at this time. (BBB)

16353 THE MAXIMUM PERMISSIBLE CONTAMINATION OF THE SOIL WITH ^{90}Sr. Reissig, Herbert (Institut fuer Bodenkunde und Standortslehre, Dresden). Wiss. Z. Tech. Hochsch. Dresden, 10: 395-403(1961). (In German).

Maximum permissible concentrations (MPC) of ^{90}Sr were evaluated for several soil types. The values were based on the MPC of ^{90}Sr for the human skeleton and on data for discrimination between Sr and Ca during passage from soil to man. Several factors that affect the ^{90}Sr concentration of soil were discussed. These included relations of ^{90}Sr in soil and the turnover of ^{90}Sr and Ca in soils, the passage of ^{90}Sr from soils by way of plants and milk to the human skeleton, evaluation of MPC of ^{90}Sr in soils, the effects of the retention of ^{90}Sr on the plant leaf surfaces or cuticles on its MPC, proportionality factors for calculation of ^{90}Sr contamination in plants and milk, and the possible effects of agronomical procedures on the MPC of ^{90}Sr. Generally, the decrease of activity in soil takes place primarily only by way of physical decay. Since the physical decay of ^{90}Sr is slow compared to man's lifetime, other, additional measures would be required to reduce concentrations of ^{90}Sr in soils, plants, or milk. This would require addition of K ions to soil, incorporation of Ca compounds in cattle fodder, or removal of ^{90}Sr from milk by ion exchangers. (BBB)

16354 RADIATION: BENEFITS AND HAZARDS. Davidanne, Sister (St. John's Hospital, Tulsa, Okla.). Hosp. Progr., 47: 50-6(Sept. 1966).

Effects of ionizing radiations, and hazards associated with their use, are reviewed, especially with reference to their use in medical radiology. The problem of determining what doses of radiation can be permitted, without biological damage resulting is discussed, as well as permissible doses to which an individual may be exposed without suffering appreciable bodily injury during his lifetime. Preliminary to an outline of the possible dangers to anyone working with x-rays or radioactive materials, the biological effects produced at various dose levels are considered, and how diagnostic and therapeutic levels of radiation contribute to these. A table gives the approximate doses of radiation delivered to the skin during various diagnostic procedures. Genetic aspects of medical irradiation are also examined. (BBB)

16355 BLOOD CONCENTRATIONS OF ^{137}Cs IN PEOPLE IN THE FAR EAST AND THE PACIFIC REGION. Yamagata, N. (Inst. of Public Health, Tokyo). Nature, 213: 1152-3(Mar. 18, 1967).

A method of blood analysis is proposed as a substitute for whole body counting in countries where expensive counters are not generally available. The method makes use of citrated whole blood made available through blood bank or transfusion systems. A minimum quantity of about 100 ml of blood is required for determination of ^{137}Cs. Measurement of the activity is made with a low background counting system, in order to measure beta activity as low as a few dpm. For the estimation of total body burden the factor relating this to blood concentration must be known; this was found to average 5.99. Data obtained since November 1965 are tabulated. Results are discussed, and it is stated that food habits are probably a cause for discrepancies as between results obtained for inhabitants of various parts of the world; high consumption of seafood may reduce the body concentrations of ^{137}Cs. It is concluded that the method of blood analysis appears to be a useful means by which worldwide information on ^{137}Cs concentrations in the general public can be obtained. (UK)

16356 THE RADIUM STANDARD FOR BONESEEKERS: EVALUATION OF THE DATA ON RADIUM PATIENTS AND DIAL PAINTERS. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-952. Health Phys., 13: 267-78(Mar. 1967).

The selection in 1941 of 0.1 μg radium as the maximum permissible skeletal burden was based on the then-studied total of about 30 cases. To date approximately 420 radium cases (about two-thirds of whom were dial painters) have been studied at M.I.T. and about 275 additional cases at Argonne National Laboratory. The results from the two laboratories are in good agreement. Approxi-

mately 100 of the M.I.T. cases ingested mixtures of ^{226}Ra and ^{228}Ra (MsTh). The MsTh radiation dose can be expressed in terms of the amount of pure ^{226}Ra which would produce the same skeletal dose measured in cumulative rads. The total effect of the mixtures is thus expressed as "pure radium equivalent", or μg Ra (PRE). No clinically significant signs or symptoms have been seen in persons with residual body burdens of less than 0.5 μg Ra (PRE). Above 0.5 μg the incidence and severity of symptoms increases with increasing body burden. The usual clinical sign of osteoporosis is followed by symptoms which include primarily osteomyelitis, spontaneous fractures, osteogenic sarcomas, and carcinomas of the paranasal sinuses or mastoids, all referable to α-ray bombardment of bone or immediately adjoining tissue. In the M.I.T. series there have been no proved cases of leukemia. Out of 81 cases of 0.5 μg Ra (PRE) or higher (up to 44 μg) the M.I.T. series contains 26 cases with osteogenic sarcoma and 7 cases with paranasal or mastoid carcinoma. Within any dose bandwidth, e.g., 2–5 μg Ra (PRE) or 10–15 μg Ra (PRE), the incidence (fraction of cases with sarcoma or carcinoma) is roughly 40 per cent and, within reasonable statistical limits, is the same for all dose levels. The time of onset for sarcomas is 7–43 yr (median 23 yr) after first exposure; for carcinomas it is 19–41 yr (median 34 yr) after first exposure. The M.I.T. and the Argonne groups have jointly developed a semiquantitative method for assigning a numerical "x-ray score" (running from 0 to 45 in the cases studied) as a single parameter describing the effects produced by skeletal irradiation. The dose (PRE)-response (x-ray score) relationships have been studied by computer techniques. A control group of 120 unexposed individuals (matched for age, sex, height and weight with the M.I.T. radium cases) has been studied to determine the x-ray score of a normal population, for comparison with the radium cases. At residual body burdens greater than 0.5 μg Ra (PRE) neither symptoms nor signs (i.e., zero x-ray score) are present in subjects with 2.6 μg Ra (37 yr) 1.3 μg Ra (30 yr), and 1.0 μg Ra (43 yr). At residual body burdens between 0.5 and 0.1 μg Ra (PRE) the M.I.T. series contains 32 symptom-free cases, in 5 of which minimal osteoporotic signs are present; between 0.1 and 0.5 μg Ra (PRE) there are 23 sign-and-symptom-free cases; between 0.05 and 0.01 μg Ra (PRE) there are 84 sign-and-symptom-free cases; below 0.01 μg Ra (PRE) there are 193 such cases. All the radium burdens reported are the residual body burdens, usually 30–50 yr after radium was taken into the body. The initial or maximum skeletal radium burden was much larger, typically about twenty times the residual burden. Clearly, the present Radiation Protection Guide or standard of a maximum skeletal deposition of 0.1 μg Ra (PRE) appears abundantly safe and conservative. (auth)

16357 BODY COUNTER EVALUATIONS OF PLUTONIUM EXPOSURES. Boss, M. R.; Mann, J. R. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Health Phys., 13: 259-65(Mar. 1967). (RFP-517).

Body counter measurements have been made on individuals who have undergone accidental exposure to ^{239}Pu. The liver, lungs and other parts of the body were measured. The exposures were the result of contaminated wounds and inhalations. Americium-241 was present in the plutonium to which the individuals were exposed. Americium-241, which emits a 60-keV gamma-ray was used as a tracer for making plutonium measurements. A plastic phantom was used to calibrate the counter by placing known amounts of ^{239}Pu and ^{241}Am into the major internal organs. The data are collected with a 512-channel pulse-height analyzer and a 4-in. by 4-mm-thick, thin-window NaI(Tl) detector. A gas flow proportional detector under development was used to supplement the scintillation detectors. About 150 unexposed people have been examined in the counter in order to establish background levels for a variety of body weights and ^{137}Cs–^{40}K content. These background levels are used as a basis for determining internal deposition. (auth)

16358 STUDY ON THE MEDICAL UNIVERSAL HUMAN COUNTER. III. SIMULTANEOUS PERFORMANCE OF ISOSENSITIVE SCANNING AND BILAMINOSCANNING. Hisada, Kinichi; Hiraki, Tatsunosuke (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 15: 354-8(Nov. 1966). (In Japanese).

For practical convenience a new technique was developed in order to perform an isosensitive scan and bi-laminoscans simultaneously at one scanning. The essential features are the addition of two oblique placed detectors to the two opposed detectors system and the mode to mix the signals additively from each detector in three combinations, recording them simultaneously with four heads of mechanical multidot tapper, two sheets of laminoscan upper and lower, one isosensitive scan and one conventional anterior scan. This system can be a help to disclose the smaller lesions in the dimensionally thick organ. (NSA of Japan)

16359 A TECHNIQUE FOR HANDLING HIGHLY RADIOACTIVE OR TOXIC MATERIALS FOR X-RAY FLUORESCENCE ANALYSIS. Karttunen, J. O. (Argonne National Lab., Ill.). Chem. Anal., 56: 33-4(Jan. 1967).

A technique for handling the placement of the dissolved radioactive material within a glass cell and then within a nylon-film pouch is announced. This nylon envelope does not interfere in the alignment of the cell and in event of rupture the sample is still retained. This method is contrasted to other handling methods commonly employed and advantages are given. (P.C.S.)

16360 EFFECTS OF LOW DOSE IRRADIATION ON PERIPHERAL BLOOD CELL COUNTS AND THEIR IMPLICATION TO HEALTH SURVEYS OF RADIOLOGICAL PERSONNEL. Sugahara, Tsutomu; Fukuda, Masashi; Hashimoto, Takaji (Kyoto Univ.). Nippon Igaku Hoshasen Gakkai Zasshi, 22: 772-82(Sept. 25, 1962). (In Japanese).

Hematologic studies were made of occupationally exposed persons in two environments and the results compared with monitoring records. Subjects included 200 persons working in a factory making radiation devices monitored since 1955 and 40 workers in a chemical institute examined since 1959. The average radiation dose before July, 1955, in the factory was estimated to be more than 300 mR/week, since adequate means of radiation protection were not used. From 1956, the dose was reduced to the level of 100 to 400 mR/4 weeks on the average. The research institute employed radiations to study polymers and their industrial applications. Various kinds of high energy apparatus were used. Exposure was always below 20 mR/2 weeks except in accidental situations. The method of Helde was used to follow the cumulative frequency distribution of blood cell counts. In the factory, no apparent change was observed in erythrocyte counts, but a marked change was observed in leukocyte counts. The tendency of a low count in relation to increased dose was noted. No such tendency was noted in the chemical institute workers. The cumulative percentage distribution of leukocyte counts appeared to provide a suitable means for detecting significant exposure at low doses. (BBB)

16361 CHANGE IN THE FIELD OF SLOW NEUTRONS AND GAMMA RAYS IN THE PRESENCE OF A PARAFFIN BLOCK. Troshev, T. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 11-18 (1966). (In Russian).

A study was made of the change in the fluxes of slow neutrons and gamma rays in the presence of a paraffin block imitating the body of the experimenter. The measurements made of the numbers of slow neutrons and the doses of gamma rays in the artificial forms of paraffin, similar to those in the human body, show maxima which appear at a distance of 2 cm between the walls. (auth)

16362 RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT OF MAN. Herbst, W. (Univ., Freiburg i. B.). Vitalstoffe Zivilisationskrankh., 7: 255-60(Dec. 1962). (In German).

Events related to the current status of radioactive contamination of man's environment are reviewed, and their biological consequences are critically examined. Requirements for additional study of biological effects of radiation upon man and his environment are briefly surveyed. The role of naturally occurring radioactivity and irradiation in the alpine foothills is evaluated. Irradiation from naturally incorporated radioisotopes, such as Ra, Th, ^{14}C, and ^{40}K amounts to 145 mR/yr, with a range of ~ ±25%, for whole-body exposure. For bone it is 200 mR/yr, for bone marrow 165 mR/yr, and for lungs 340 mR/yr. In regions located high in the Alps the whole-body dose is 320 mR/yr, and it is 380 mR/yr for bone and bone marrow, and more than 1000 mR/yr for lung. Although there are values of maximum permissible concentrations for air, water, and personal exposure to irradiation, none has been established for foodstuffs. The levels of radioactive contamination of foodstuffs used for animal fodder and in human nutrition are reviewed and discussed. Values of ^{90}Sr in various grains and vegetables, in milk, and in bones of small children are estimated. The distribution of ^{137}Cs in foodstuffs is briefly discussed. The possible significance of incorporated radioisotopes is discussed, and the possibility of increased lethal effects in the event of atomic warfare is briefly evaluated. (BBB)

16363 DOSIMETRIC PROBLEMS IN COMBINED RADIUM AND TELECOBALT IRRADIATION. Frischbier, H. J. (Univ., Eppendorf-Hamburg, Ger.). Arch. Gynaekol., 202: 316-20(1965). (In German).

When the uterus is situated exactly at the midline and is treated with 4500 mg/hr of Ra and 4000 R of ^{60}Co γ irradiation over 2 abdominal and 2 dorsal fields, it is possible to achieve a very adequate dose summation. At the same time 4 cm laterally from the midline 6000 R are received, which is the maximum tolerance for bladder, rectum, and ureters. However, if the uterus is located 2 cm laterally from the midline, a dose of 7000 R is received 5 cm lateral to the midline, so that the ureter receives a considerably higher dose. Also, the parametrium may be underirradiated, receiving 4000 R or less. These positional

differences are much more important in combined Ra and ^{60}Co γ therapy than in conventional x ray treatment. The exact position of the uterus should be ascertained before combined treatment is used. Filters should be used that will attenuate the medial radiation more strongly than at the sides of the field. Another way to reduce the possibility of exceeding the prescribed dose limit is to reduce the Ra dose given. The ^{60}Co dose can be adjusted to compensate for this. In advanced tumors where the tumors are more extensive than the range of localized Ra treatment the Ra treatment can be replaced completely by the ^{60}Co irradiation. In order to irradiate the entire lymphatic area without increasing the volume dose, both of the 18-cm long parametrial fields should converge along their axes at an angle of 15°. This gives an 80% isodose in the lymph nodes and along the lower spine. (BBB)

16364 INFORMATION YIELD FROM RADIOGRAPHS. Barr, John H. (Tufts Univ. School of Dental Medicine, Boston). Oral Surg., Oral Med., Oral Pathol., 22: 174-82(Aug. 1966).

A discussion is provided on the information yield from radiographs in dental practice. Possible approaches to upgrading the yield were explored, and specific suggestions were developed to assure a more rewarding yield of information from radiographic studies. Improved methods of examining radiographs are particularly important when patient exposure dose-reduction techniques are used. Considerations of lowering radiation exposure dose emphasize the need for precise criteria for the diagnostic acceptability of radiographs. Complaints by dentists about films associated with dose-reducing techniques are frequent but are seldom well founded. Films which may not appear attractive or dramatic to the viewer may actually present a superior information content, but the viewer is unlikely to accept this possibility, even in the interests of radiation dose reduction, without more convincing objective evidence than has yet been developed. Problems arising from radiation dose reduction are particularly concerned with the image density and contrast of radiographs. Such control in radiographic practice is well understood, and existing densitometric procedures permit objective evaluation of these image characteristics. Optimal conditions for examining films produced by low-dose techniques are presented. The intensity of illumination should be evenly distributed over the entire film area, which implies an adequately distributed light source behind a flawless opaque glass, the latter kept scrupulously clean at all times. The reflected or environmental light which may compete with the transmitted light of the illuminator must be reduced. Stray light should be excluded from the periphery of films by means of dark opaque film mounts. Magnification of the image by use of a reading glass of about 2× or 3× power is useful, not only to enlarge the image to reveal more detail but also to reduce the field that each film must be viewed separately. (BBB)

16365 PRELIMINARY RESULTS OF A SYSTEMATIC STUDY OF INTERNAL CONTAMINATIONS FOLLOWING RADIOACTIVE FALLOUT. Pellerin, P.; Moroni, J.-P.; Remy, M.-L. (Service Central de Protection contre les Rayonnements Ionisants, Le Vesinet, France). Rev. Hyg. Med. Soc., 13: 49-60(Jan.-Feb. 1965). (In French).

Data are presented for some human body burdens of fallout radionuclides as assayed from September 1961 to February 1964. Since September 1961, more than 500 tests in the human whole-body counter have been carried out by the Central Protection Service. Urinary radioanalysis (γ spectrometric and radiochemical analysis) associated with these tests revealed certain facts relative to internal contamination due to radioactive fallout. Cesium-137 was the only artificial radioisotope consistently detected by the total-human counter test, and it was possible to study, from the weak activity usually found, the relation between the urinary excretion of this isotope and its total-body level. At certain periods, evidence was found for body contamination with fission products having half-life values corresponding to $^{95}Zr-^{95}Nb$, and ^{103}Ru. Traces of $^{140}Ba-^{140}La$ were noted in March 1962. In the weeks immediately following thermonuclear explosions in the atmosphere, minimal quantities of ^{131}I were detected with the human whole-body counter for short periods. In general, the human body levels for short-lived isotopes were higher in persons living 250 km from Paris than in that city itself; this may reflect the shorter alimentary chain in the rural areas. Highest ^{137}Cs levels in the body were found in Feb. 1964 (total-body level in man 25,900 pC, or 198 pC/g K) while the level in milk was highest in August 1963 (420 pC/l). The mean daily ^{90}Sr urinary excretion level for 1963 and early 1964 was 5.7 pC/day. (BBB)

16366 DOSIMETRY. Frischkorn, R. (Univ., Goettingen, Ger.). Arch. Gynaekol., 202: 274-88(1965). (In German).

The measurement of high-energy x radiation and particulate radiation is reviewed. Scintillators, production of luminescence induced by uv, nonconductors or semi-conductors that change conductivity, crystals whose absorption is altered by irradiation, photographic emulsions, chemical reactivity changes, and calorimetry represent a few of the materials and methods available for measurements. Various radiation units and mechanisms of energy transfer in tissues are discussed. Procedures and possible sources of error in dosimetric procedures are outlined. Radiometric measurements of free air dose and incident dose are outlined, and the significance of surface dose, maximum dose, standard ion dose for determination of focal dose, etc. is considered. The relation of ionization density to the direction of scattered radiation is outlined, with particular emphasis on the tendency of secondary electrons in the megavolt range to travel in the direction of the primary radiation beam. Depth dose curves in water for x radiation from 200 keV to 35 MeV are shown. An example of energy loss of a 10-MeV electron during its deceleration, with production of 3-MeV secondary electrons, is illustrated and discussed. Depth dose curves for monochromatic electron radiation from 5 to 35 MeV are illustrated. (BBB)

16367 A CONTRIBUTION TO THE REDUCTION OF RADIATION DOSES IN STOMATOLOGIC X-RAY PRACTICE. Schwerin, L. (Staatliche Zahnarztpraxis, Laussnitz, Ger.). Deut. Stomatol., 16: 104-14(Feb. 1966). (In German).

Methods for the reduction of radiation dose in dental radiography are reviewed. (TSS)

16368 RADIOPROTECTION PROBLEMS OF RADIODIAGNOSIS IN SURGERY. Buechner, H. (Univ., Munich). Radiologe, 6: 316-20(Aug. 1966). (In German).

The annual rate of increase in x-ray studies used in diagnostics amounts to ~10%. Special x-ray diagnostic procedures that require particular attention to radioprotection include preoperative x-ray studies on the skeleton, organs, and soft tissues, postoperative follow up studies, and specialized studies in the field of surgical-orthopedic diagnostics. Survey performed in connection with thoracic studies indicate that the gonadal dose from a single thoracic photograph is equivalent to the irradiation received during an air flight over the U. S. The dose from thoracic fluoroscopy is ~333 times as great. There is evidence for increased gonadal doses associated with orthopedic hip photographs, gained through years of experience with treatment of hip dysplasias and luxations. In female infants less than one yr old the ovaries have not reached the level of the linea interspinalis but in projection are near the lower pole of the ileosacral joint. With a properly placed shield the gonadal dose can be reduced by 20 to 30%. In male children the dose can be reduced to 0.5% by use of a leaded rubber strip. Patients of reproductive ages with appendicitis should not be diagnosed with x ray. Studies made on 700 hospital patients have indicated that the average radiation dose received is increased by a factor of 2 or 3 because of personnel turnover and may increase by 5–9 times of the environmental dose because of poor technique. (BBB)

16369 EVALUATION OF THE INFLUENCE OF THE HALF-VALUE LAYER ON THE DIAGNOSTIC QUALITY OF INTRAORAL ROENTGENOGRAMS. Crandell, C. E. (Univ. of North Carolina, Chapel Hill). Oral Surg., Oral Med., Oral Pathol., 21: 39-46(Jan. 1966).

The quality (or half-value layer, HVL) of an x-ray beam that will produce films preferred by the greatest number of dentists was investigated by exposing films at various HVL, by having dentists rank these films according to their diagnostic value, and by analyzing statistically their ranking of the films. A survey of 117 dental x-ray machines resulted in selection of four variations of HVL, which correspond to 65 kvp with no added filter, 65 kvp with 1.75 mm of aluminum added, 90 kvp with no added filter, and 90 kvp with 3.0 mm of aluminum added. The corresponding HVL's were in the order of 1.1, 1.6, 1.4, and 4.4 mm of aluminum. The HVL chosen by the panel for the upper molar region was 1.4, followed by 1.6, 4.4, and 1.1 mm of aluminum in that order. The HVL of choice for the lower molar region was also 1.4 mm of aluminum. This selection indicates a preference for films with wide latitude (as achieved by higher kilovoltages) and high contrasts (as achieved by not using a filter). However, these two factors are not mutually compatible. An HVL of 1.4 mm of aluminum can be achieved by various kvp-filter combinations, but the one in this study involved 90-kvp with no filter. This is not compatible with popular radiologic health protection methods. It appears that further attempts to achieve reduction in radiation dose through the use of higher HVL, increased filtration, and higher voltage will not be productive. It is suggested that optimum levels for present equipment and films lie within the ranges now in use. Further research into radiation protection probably should

be directed along other avenues. The diagnostic quality of films rather than dosage considerations must continue to be of primary concern in the light of inadequate knowledge of genetic damage and the availability of adequate radiologic health measures. It is necessary that the accepted physical factors used in producing roentgenograms be flexible, thereby achieving a favorable balance between the benefits derived from diagnosis and the hazard of mutation. (TCO)

16370 THE REMOVAL OF ^{90}Sr FROM MILK. PART I. SURVEY OF LITERATURE AND EXPERIMENTS ON THE USE OF BONE PREPARATIONS AS ADSORBENTS. Seidler, H.; Haertig, M. (Institut fuer Ernaehrung, Potsdam-Rehbruecke, Ger.). Nahrung, 9: 735-43(1965). (In German).

Previous reports (55) relating to hazards of fallout ^{90}Sr in dairy products and its removal from milk are reviewed. A discussion is provided on factors that must be considered relative to the necessity for decontaminating restricted quantities of milk in case of a nuclear disaster. Also dealt with are the distribution of ^{90}Sr in milk and the reduction of the ^{90}Sr activity in milk and milk products that can be obtained by simple procedures. A survey is given of the results of investigations on the efficiency of bone preparations in removing ^{90}Sr from milk. A survey is also given on publications dealing with the decontamination of milk by means of resin ion exchangers. The cost of ^{90}Sr removal by various methods is also estimated. (BBB)

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Refer also to abstracts 16201, 16301, 16321, 16363, 16364, 16451, 16458, 16466–16470, 16474, 16489, 16492, and 16512.

16371 (AD-639641) CHEMICAL PROTECTION AGAINST RADIATION DAMAGE TO AN IMMUNE RESPONSE IN MOUSE SPLEEN CELLS IN VITRO. Report for September 1, 1965–February 28, 1966. Kollmann, George; Freidman, Herman; Shapiro, Bernard (School of Aerospace Medicine, Brooks AFB, Tex.). Aug. 1966. Contract AF 41(609)-2637. 13p. (SAM-TR-66-69). CFSTI $3.00 cy, $0.65 mn.

Swiss Webster mice were sensitized by injection of sheep red blood cells and were sacrificed 4 days later. Suspensions of teased spleen cells were made and irradiated in the presence of MEG, GED, ascorbic acid, dehydroascorbic acid, or no agent. The cells were incubated after plating with agar, sheep red cells, dextran, and complement, and hemolytic plaques were counted. Plaques represent spleen cells that are still able to release antibody. Radiation reduced the number of plaques formed with a D37 of 8 to 16 kR. MEG, GED, and dehydroascorbic acid did not protect. Ascorbic acid showed good protection with D37 of 44, 33, 50 in three separate runs. The mechanism of this protection is under study. (auth)

16372 (COO-1472-11) DIGITAL COMPUTER ANALYSIS OF RADIONUCLIDE SCANS. Brown, Donald W.; Groome, D. S. (Colorado Univ., Denver. Dept. of Radiology). Jan. 26, 1967. Contract AT(11-1)-1472. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A system is described for analyzing data collected by radioisotope scanning procedures with a digital computer. Data acquisition is achieved by means of an incremental magnetic tape recorder. Pulses from the pulse height analyzer of a commercial five-inch NaI crystal rectilinear scanner enter a modified Beckman accumulator. Counts from the accumulator are transferred to the shift register boards of a Beckman intercoupler that is directly connected to an IBM 1800 with a 16K memory and two discs. Data are processed statistically and pictures of the organ under study are printed out by the computer using the printer for an X-Y plot. A study of 100 consecutive scans resulted in an overall accuracy of 92% and was comparable with conventional photoscans. Computed scans are advantageous in that they allow objective evaluation of serial changes. (H.G.D.)

16373 (JPRS-38272, pp 46) MATERIAL ON THE PHARMACOLOGICAL PROTECTION OF THE VESTIBULAR ANALYZER IN THE CASE OF RADIATION EFFECTS. Arlashchenko, N. I.; Suslova, L. N.; Kvasnikova, L. N. Translated from pp 39 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The physiological response of the vestibular apparatus of healthy and irradiated rabbits to radioprotective compounds was studied by means of evaluation of the nystagmus response and measurements of respiration in the vestigular apparatus after the prophylactic administration of vitamins and amino acids or the administration of aminozine, which prevents primary radiation reactions. The radioprotective compounds caused more rapid normalization of the vestibular reactions to the effects of ionizing radiation but increased the time required for normal response to stimuli. Implications of the findings on the performance of the mission by the crew of a spaceship are considered briefly. (C.H.)

16374 (JPRS-38272, pp 296-7) THE NEGATIVE INFLUENCE OF RADIATION-PROTECTIVE PREPARATIONS ON THE MOTOR-EVACUATORY FUNCTIONING OF THE GASTROINTESTINAL TRACT. Krasnykh, I. G.; Mansurova, A. R. Translated from pp 229-30 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The effects of certain radioprotective compounds, administered intraperitoneally, by mouth, or rectally at doses that give maximum protection in irradiated animals, on gastrointestinal tract functional activity were studied in non-irradiated rats. Observations of functional activity were made by radiography after the administration of barium sulfate. The radioprotective substances tested included cystamine, β-aminoethylisothiuronium, the sodium salt of β-aminoethylthiophosphoric acid, and 5-methoxytryptamine. All the compounds tested retarded the passage of the contrast media from the stomach, caused a disturbance of tonus and peristalsis, and retarded evacuation. It is suggested that the lowered effectiveness of radioprotective compounds given by mouth may be due to an effect on gastrointestinal function that delays absorption from the intestine. (C.H.)

16375 (JPRS-38272, pp 366) THE INFLUENCE OF RADIATION-PROTECTIVE PREPARATIONS ON THE FUNCTIONAL STATE OF THE HUMAN ORGANISM. Mozzhukhin, A. S.; Kuznetsov, V. I.; Kuzhakovskaya, M. S.; Makhalova, O. K.; Goryachev, I. A.; Solntsev, S. A.; Shostak, V. I.; Kudrin, I. D. Translated from pp 282-3 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The effects of cystamine were tested in over 500 healthy individuals. It was established that the maximum tolerable dose of cystamine is 1.2 gram each dose, 0.8 gram when taken every 6 hr during the day, and 0.6 to 0.8 gram when taken once each day for a month. This dose did not cause any significant change in the working ability, cardiovascular function, respiration, digestion, excretion, or nervous response of the individuals. About 10% of the individuals experienced nausea or brief unpleasant sensations in the epigastric region. (C.H.)

16376 (JPRS-38272, pp 435-6) PROBLEMS OF THE PHARMACOCHEMICAL PROTECTION OF AN ORGANISM FROM IONIZING RADIATION ON SPACE FLIGHTS. Saksonov, P. P.; Antipov, V. V.; Dobrov, N. N.; Kozlov, V. A.; Shashkov, V. S. Translated from pp 335-6 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The known radioprotective compounds cannot be used to afford radiation protection to astronauts under conditions of space flight since they increase sensitivity to factors encountered such as vibration. Basic requirements for chemical radioprotective compounds for use during space flight are outlined. (C.H.)

16377 (JPRS-38272, pp 462-3) REDUCTION OF THE EFFECTIVENESS OF CHEMICAL PROTECTION WITH SMALLER DOSES OF RADIATION. Suslikov, V. I. Translated from pp 356-7 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The hypothesis that the lessening of the effectiveness of radioprotective compounds for the protection of mammals against a reduction of lethal radiation dose may be due to the toxic effects of the compounds is discussed. (C.H.)

16378 RADIOACTIVE PHOSPHORUS IN THE TREATMENT OF METASTASIS TO BONE FROM CARCINOMA OF THE PROSTATE. Morin, Lawrence J.; Stevens, Joseph C. (Dartmouth Medical School, Hanover, N. H.). J. Urol., 97: 130-2(Jan. 1967).

Trials were conducted in six patients on the use of ^{32}P to control pain in bone metastases. Estrogen therapy was discontinued first and then steroid treatment, if possible. A 100-mg dose of testosterone cypionate in cottonseed oil or testosterone enanthate in sesame-seed oil was administered intramuscularly each day for 7 days. After the first 5 days of administration of testosterone, 5 to 7 mCi of radiophosphorus was given intravenously in a single dose. On the tenth day, estrogen therapy was resumed. Rapid and essentially complete relief of pain was noted. Significant bone marrow depression was not evident in any of these patients, although a decrease in platelets was occasionally seen 5 to 6 weeks after therapy. Two reasons given for the lack of marrow depression were that testosterone was a stimulant of erythropoiesis and that a high percent of the administered ^{32}P appeared to be taken up by metastatic areas instead of by normal bone marrow areas. (BBB)

16379 TREATMENT OF INVASIVE CARCINOMA OF THE CERVIX DURING PREGNANCY. Pratt, Joseph H.; Malkasian, George D. (Mayo Clinic, Rochester, Minn.). Ann. N. Y. Acad. Sci., 114: 868-74(Apr. 2, 1964).

Problems encountered in radiotherapy during pregnancy are considered, especially in relation to fetal salvage. Five of 6 patients with carcinoma of the cervix diagnosed in the first trimester of pregnancy were treated by irradiation; all 5 aborted in 2 to 4 weeks. Four of the 5 patients died within 1 yr of metastatic malignant lesions. The sixth patient had a Stage I lesion, was treated surgically, and survived 5 yr. Management of invasive cervical cancer in the pregnant patient is complicated because of the interest in the fetus, but there is agreement that the patient having a cancerous lesion found during the first trimester should be treated by any chosen modality with complete disregard for the fetus, for it will be lost in any case. Most physicians prefer radiation therapy. When radiation is utilized, starting either with external radiation or with radium given directly to the cervix, abortion occurs in about 1 month. The remainder of the calculated dosage of radiation can then be given. If abortion does not occur, the uterus should be emptied by curettage; a week later, additional therapy can be given. Preliminary emptying of the uterus by curettage, however, is not advisable. During the second trimester, because the fetus is larger and stronger, abortion is less likely to occur and, therefore, treatment with radium must be started and hysterotomy or hysterectomy must be performed. A week later appropriate radiation therapy should be used. During the sixth and seventh months of pregnancy, the question of viability of the fetus must be considered. A delaying action by the application of radium to the cervix to hold the malignant lesion in check for one to two months is of possible value, but the effect on the fetus must also be considered, though major anomalies probably will not occur at this stage of gestation. It is preferable to treat the cancer and hope to offer the maximal prognosis to the patient. During the third trimester, cesarean section must be the first step. (BBB)

16380 TRANSSPHENOIDAL ^{90}Y HYPOPHYSECTOMY IN THE TREATMENT OF BREAST CANCER. Dohn, Donald F.; McCullagh, E. Perry (Cleveland Clinic Foundation, Ohio). Postgrad. Med., 40: 402-7(Oct. 1966).

Use of pituitary ^{90}Y implantation is described, with an account of the complications and their treatment, assessment of the effectiveness of radiotherapy, and a comparison of the use of ^{90}Y, ^{198}Au, Rn, and external x irradiation and ^{60}Co γ irradiation of the pituitary. Compared with other methods of hypophysectomy, transsphenoidal ^{90}Y pituitary ablation proved to be a simple and well-tolerated procedure. There was good correlation of the degree of pituitary destruction as measured by the metyrapone test with the necrosis observed on serial section of the pituitary post mortem and with the clinical remission. The ^{90}Y implanted in the pituitary appears to destroy the gland completely or almost completely in most cases. In 69 of the 160 cases followed up long enough to permit an evaluation of the effectiveness of the procedure, 21, or 30% had effective objective remission. Complications of transsphenoidal ^{90}Y hypophysectomy in 100 patients are tabulated. Extraocular muscle palsy occurred in 4 patients but subsequently cleared and nasal hemorrhage occurred in 4 patients. In all cases the hemorrhage was controlled by a posterior nasopharyngeal pack. Diabetes insipidus as a temporary phenomenon was common (47%). Even when it is permanent, however, it is easily controlled either by chlorothiazide or by bendroflumethiazide with potassium chloride and usually subsides after a few months. Cerebrospinal fluid rhinorrhea developed in 12%. Meningitis occurred in 6 patients who had rhinorrhea and in one other patient without rhinorrhea. Five of these patients were successfully treated but one died. In 8 patients, rhinorrhea was controlled by a simple transsphenoidal repair utilizing the same equipment as for the original ablation operation. This is accomplished by inserting a muscle homograft into the sella turcica through one of the original drill openings and firmly replacing a nonradioactive screw. (BBB)

16381 CHROMOSOMAL ABERRATIONS FOLLOWING RADIOIODINE THERAPY. Cantolino, S. J.; Schmickel, R. D.; Ball, M.; Cisar, C. F. (Johns Hopkins Hospital, Baltimore). New Engl. J. Med., 275: 739-44(Oct. 6, 1966).

Data are presented which suggest that therapeutic doses of radioiodine used in the management of thyrotoxicosis can cause significant and persistent chromosomal damage in peripheral leukocytes. In 5 adult hyperthyroid patients treated with ^{131}I, 3500 cells were examined and scored for chromosomal aberrations at 7 different intervals from 2 hr up to 1 yr after administration of a single therapeutic dose of 5 mC. In all subjects after the administration of a single therapeutic dose, a significant number of chromosomal aberrations was seen, including rings, dicentrics, and acentric fragments at all intervals up to and including 1 yr after treatment. The general incidence of aberrations was undiminished after 1 yr. None of the post-treatment intervals, from 2 hr to 1 yr, showed a peak incidence of aberrations. There was no positive correlation between the level of ^{131}I activity in the plasma of these subjects and the incidence of aberrations. (BBB)

16382 A COMPUTERIZED RADIOISOTOPE-SCAN-DATA FILTER BASED ON A SYSTEM RESPONSE TO A POINT SOURCE. Sprau, Allan C.; Tauxe, W. Newlon; Chaapel, Donald W. (Mayo Clinic, Rochester, Minn.). Mayo Clin. Proc., 41: 585-98(Sept. 1966).

One of the major deficiencies of current scintiscanning devices is that the displays imply a resolution that is inconsistent with the response characteristics of the scanning system. Initial results of attempts to solve the problem of inconsistent resolution by utilization of a digital computer are reported. Scintiscan information was gathered and stored by a multichannel digital magnetic tape recorder. The tape from this recorder was used as a direct input to an IBM 7040 computer. A point source of ^{131}I was scanned with the use of a 19-hole collimator to obtain the point-source response of the scanning system. This response function was a three-dimensional bell-shaped surface. The filtering process was a form of weighted average with the weights derived from the system response function. In a preliminary clinical series, this filtering process afforded a significant improvement in scintiscans, because each of as many as 20 levels of counting-rate intensity could be clearly separated and represented by a symbol. Maximum resolution was obtained when the data were handled in a digital rather than analogue form, since actual count rates were presented and the data matrix could be handled by various mathematical maneuvers. (BBB)

16383 METABOLIC EFFECTS OF SOME RADIOPROTECTORS. Bacq, Z. M.; Liebecq, C. (Univ., Liege). pp 111-41 of Drugs and Enzymes. Proceedings of 2nd Intern. Pharmacol. Meeting, August 20–3, 1963, Prague. Oxford, Pergamon Press, 1965. (In French).

A review of available literature on the metabolic effects of some radioprotective compounds was made. It was suggested that most so-called radioprotectors have only prophylactic effects and that they were not therapeutic agents since they have been found to be inactive when administered after irradiation. The roles of cysteamine and cyanide as inducers of hypoxia, the roles of thiols and disulfides as scavengers of free radicals, and other properties of radioprotective compounds that may take part in radiation protection are discussed. It was concluded that radioprotective compounds appear to act by various mechanisms and that the effects of the mechanisms may be additive. (TSS)

16384 SPONTANEOUS RUPTURE OF THE BLADDER. Altman, B.; Horsburgh, A. G. (Westminster Hospital, London). Brit. J. Urol., 38: 85-8(Feb. 1966).

Two cases of radioinduced bladder injury that resulted in rupture of the bladder are reported. In the first case, a 55 yr-old man was treated for rectal carcinoma and received a total dose of 5136 R γ radiation over a 40 day period. Six months later, he underwent further radiotherapy and a radiation dose of 3276 R was administered over a 38 day period. Five months posttherapy, a 2-cm ragged tear was observed in the fundus of the bladder; petechiae and thickening of the pelvic peritoneum indicated radiation damage. In the second case, a total dose of 6000 R was administered by insertion of Ra applicators during radiotherapy of cervical carcinoma. A hysterectomy was performed and followed by x ray radiotherapy; total tumor dose was 2400 R in 36 days. Five years later, rupture of the bladder occurred; a 6-cm ragged linear tear occurred in the right posterosuperior aspect of the bladder. The bladder wall was found to be of normal thickness with no obvious radiation damage. The right pelvic wall showed petechiae subperitoneally as the only evidence of radiotherapy. The role of radiotherapy in production of bladder rupture is discussed. The possibility that cancer recurrence and/or bladder infection was partially responsible is mentioned. (TSS)

16385 ^{99m}Tc COLLOIDAL SULFIDE LIVER AND SPLEEN SCANNING WITH DATA BLENDING. Freeman, Leonard M.; Rosen, Richard A. (Bronx Municipal Hospital Center, N. Y.). N. Y. State J. Med., 67: 291-2(Jan. 15, 1967).

Preparation of the colloidal sulfide of ^{99m}Tc is described. One mCi was used for liver scanning, whereas a greater dose, 3 to 5 mCi, was needed for spleen and/or bone marrow scanning. The scan was started 15 min after the intravenous administration of the radionuclide. One mCi of ^{99m}Tc colloidal sulfide gave 35,000 to 40,000 cpm in a normal liver, whereas lower count rates were encountered in cirrhosis. In this condition, the spleen and often bone marrow could be visualized with as little as 1 mCi of ^{99m}Tc colloidal sulfide. The dose from 1 mC of ^{99m}Tc colloidal sulfide was 0.24 to 0.33 rad to the liver, 0.16 to 0.43 rad to the spleen, and 0.017 rad of total-body radiation. This compared favorably with colloidal ^{198}Au where the usual dose of 150 μC delivers 3.9 to 6.4, 3.7 to 11, and 0.35 rad, respectively, to the same organ systems. It was concluded that the data blending process was adaptable to conventional scanning apparatus and added to the diagnostic accuracy of scan interpretation. (BBB)

16386 BREAST TUMORS OF THE ATOMIC BOMB CASUALTIES. Harano, Chicao; Tezuka, Hiroshi; Furukawa, Hiroshi; Deguchi, Noboru (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 38: Suppl., 114-16(Dec. 1963). (In Japanese).

From January 1946 to October 1962, there were 155 cases of breast tumors submitted to surgery. There was no difference of frequency in the development of breast tumor between casualties and noncasualties (casualties are defined as persons who were within 5 km of the hypocenter). There was a slight increase of such cases since 1953 but the casualty group did not show a significant increase. There was no marked difference in age distribution between these two groups. There was no evidence as to differences between the casualties and noncasualties in terms of the location of mammary tumor and the exposed distances. A larger sample will be required before definite conclusions relating cancer incidence to degree of exposure can be drawn. (BBB)

16387 CHEMICAL PROTECTION AGAINST IONIZING RADIATIONS IN MAMMALS. Bacq, Z. M. (Univ., Liege). Bull. Acad. Roy. Med. Belg., 6: 115-44(1966). (In French).

A review of the literature as well as some recent experimental results indicates that the classical hypotheses of hypoxia, mixed disulfides, and free radicals scavenging are inadequate in explaining the protection afforded to rats or mice by cysteamine or cystamine injections. A new concept of biochemical shock is postulated to explain the new as well as the previous evidence. Intraperitoneal injection of a radioprotective dose of cysteamine or cystamine in rats or mice induces, within a few minutes, mitochondrial lesions in the radiosensitive organs (spleen, thymus, duodenal mucosa), defective carbohydrate metabolism, and a drop in oxygen consumption and in respiratory quotient. Certain of these effects can be found in isolated systems (liver homogenates, isolated mitochondria). A time lapse of 10 min is necessary, after intraperitoneal injection of cysteamine in mice, for the development of maximum protection against irradiation. Cystamine in mice, however, gives a high degree of protection as early as 2 min after injection. The degree of protection falls at 6 min and again rises at 10 min postinjection. Later it decreases in a way that is similar to the protection afforded by cysteamine. Cystamine (1% in food) administered continuously does not protect mice against continuous exposure to ^{137}Cs γ rays at low doses (from 0.026 to 1 R/min). (BBB)

16388 CHRONOBIODOSIMETRICAL EVALUATION OF THE RADIOSENSITIVITY OF THE CRYSTALLINE LENS AND THE RETINA AND THE DOSAGES USED IN RADIOTHERAPY OF OCULAR AFFECTIONS. Boles-Carenini, B.; Balestra, E.; Laudenzi, C. (Univ., Genoa. Univ., Sassari, Italy). Minerva Radiol., Fisioterap. Radiobiol., 11: 541-5(Oct. 1966). (In Italian).

On the basis of the data reported in the literature it is reported that the safe biodoses for the crystalline lens and the retina are about 0.20 and 1 chronic erythema dose respectively. In conservative treatments of the eye these figures must not be exceeded. In treatments carried out on the anterior segment of the eyeball, however, low penetration techniques must be used: beta rays, border rays, and plesio-roentgenotherapy. (auth)

16389 PHYSICAL AND RADIOBIOLOGICAL ASPECTS OF SHADE IN RADIOTHERAPY. I. EFFECTS OF SHADE IN TELECESIOTHERAPY. Calzavara, F.; Piazza, G.; Pozza, F. (Univ., Pavia, Italy). Minerva Radiol., Fisioterap. Radiobiol., 11: 529-32(Oct. 1966). (In Italian).

The results of an experimental study of the effects of the shaded area in tissues crossed by a beam of ^{137}Cs rays are reported. After a photographic dosimetric check of the width of the shaded area at the depth of 1.0 cm in material equivalent to organic tissue, the radiobiological effects in this critical area in rat liver tissue are described. The characteristic lesions of the shaded area seems to be of the discontinuous focal type. The possible causes of this uneven reactivity are discussed, stressing the biological and physical aspects involved. (auth)

16390 TELECOBALT IRRADIATION OF MALIGNANT BONE TUMORS. Hoppe, Dietrich (Universitaets-Geschwulstklinik der Charite, Berlin). Deut. Gesundheitsw., 20: 759-62(Apr. 29, 1965). (In German).

The radiosensitivity of bone tumors is considered as well as optimal modes of irradiation which will insure an adequate dose to bone. Data collected from the literature are discussed regarding the radiosensitivity of the various types of tumors, which are classified as osteoblastic, chondroblastic, and fibroblastic osteogenic sarcomas, pure chondrosarcomas, reticulum cell sarcomas, multiple bone myelomas, Ewing sarcomas, fibrosarcomas, malignant chordomas, liposarcomas, and neurosarcomas. These tumors possess a different radiosensitivity, particularly with regard to telecobalt irradiation. Since 1959 bone sarcomas were treated by telecobalt in this clinic; 56 patients with different kinds of sarcomas were treated. Irradiation therapy was carried out with stationary fields (25 × 25 cm) which were irradiated alternately. This irradiation aimed at a total dose of 8000 to 10,000 R. Three months after irradiation therapy, 21 patients had to undergo amputation. The results of the treatment of bone sarcomas were not completely satisfactory. After 2 yr, 26 sarcoma patients, i.e., 46.4% were still alive. Six patients have survived 3 years, while one patient is free from metastases 5 years after ^{60}Co therapy. In spite of the relatively high dose to bone with ^{60}Co radiation (the ratio of bone/soft tissue absorption of energy is ~1.8), osteoradionecrosis was not a problem with the doses used. (BBB)

16391 PRELIMINARY REPORT CONCERNING THE USE OF INTRAARTICULAR RADIOACTIVE GOLD, ^{198}Au, IN THE TREATMENT OF PERSISTENT EFFUSIONS OF THE KNEE. Lachance, Paul-Andre; Drouin, Rene; Dube, Jean; Paquet, Claude (Hopital du Saint-Sacrement, Quebec). Laval Med., 37: 239-42(Mar. 1966). (In French).

Ten patients were treated with injections of ^{198}Au for chronic inflammatory conditions of the knee joint; clinical results and complications are reported. Trials were prompted by successful use of ^{198}Au in effusions of the pleura and peritoneum. In these cases, and in effusions of the knee, collection of fluid occurs within a thin, endothelial membrane. Doses of 2 to 5 mCi of ^{198}Au (mean 3.3 mCi) were injected intra-articularly. Eight of the 10 patients had rheumatoid arthritis, one psoriatic arthritis and one gout. No immediate reactions were noted, but in some cases there was a marked increase of fluid in the joint; however, this disappeared in two to three weeks. In 7 cases the results were considered good. That is, joint flexibility increased, pain and edema decreased in soft tissues, and clinically detectable effusion subsided. In only one case did effusion recur. In most patients the resorption of excessive joint fluid was gradual and was complete within ~ a month after injection. Biopsies of synovium showed a marked reduction of inflammation and a slight increase of synovial fibrosis. (BBB)

16392 RELATIONS BETWEEN LYSOZYME AND THE LEVEL OF ADRENAL CHOLESTEROL IN WHOLE-BODY IRRADIATED RATS. Costa, A. L.; Spadaro, M.; Mundo, A. (Univ., Messina, Italy). Boll. Soc. Ital. Biol. Sperim., 42: 1280-3(1966). (In Italian).

Adrenal gland cholesterol content is known to drop sharply after whole-body irradiation, and this reaction has been interpreted as a general response to a stressful stimulus. The possibility that injections of lysozyme might protect against this response was tested by injecting purified lysozyme (a basic protein) or gelatin (an acidic protein) at various times prior to irradiation. Female Wistar rats weighing 250 g were exposed to a 1200-R dose of 180-Kv x rays, and levels of adrenal cortical cholesterol were determined, at intervals, up to 192 hr postirradiation. In the lysozyme-injected rats, the drop of adrenal cholesterol (maximal at 12 hr postirradiation) was only half as great as that in rats injected with distilled water, saline, or galatin. Furthermore, the cholesterol content of the adrenals rose above the basal value after 2 to 3 days in the lysozyme-treated animals, but remained below this level in the other group. It is suggested that such small doses of lysozyme that were used (4 mg/kg body weight) exert a protective effect against radiation-induced stress. (BBB)

16393 TREATING HEAD AND NECK CANCER WITH RADIOACTIVE ISOTOPES. Ariel, Irving M. (Pack Medical Foundation, Inc., New York). Arch. Otolaryngol., 83: 360-7(Apr. 1966).

Physical characteristics of 28 radioisotopes and their therapeutic uses, especially in treating head and neck cancers, are considered. Various physical forms (e.g., microspheres, colloids, seeds) of the isotopes, as well as their chemical combinations, are discussed. Techniques and dose data are provided, with reference to 51 patients. Radioisotopes may be administered intravenously, intra-arterially, by contact, and/or into body cavities. Combinations of isotopes may also be used. Different radiation spectra have been tailored for treating certain cancers of the head and neck, and examples are presented. Following external radiation therapy, radioisotopes have been found particularly useful in the treatment of recurrences. (TCO)

16394 THERAPEUTIC HYPOPITUITARISM. Jadresic, Alfredo (Hospital San Juan de Dios, Santiago de Chile). Rev. Med. Chile, 93: 415-25(July 1965). (In Spanish).

The use of ^{90}Y, ^{192}Ir, and ^{198}Au implantation in the pituitary to diminish or abolish function of the gland in 80 cases of metastatic prostate or breast cancer or of diabetic retinopathy is described, as are complications of the procedure. The risks with this procedure are less than with surgical ablation of the gland. Two patients implanted with ^{90}Y developed meningitis secondary to rhinorrhea,

8 developed rhinorrhea, and 3 incurred optic nerve damage. Pituitary irradiation resulted in diminished urinary excretion of 17-ketosteroids and 17-hydroxycorticosteroids. Thyroid and gonad function also decreased. In 70% of the patients, diabetes insipidus developed 24 to 48 hr after radioisotope implantation, as evidence of injury to the neurohypophysis. In most cases this condition disappeared spontaneously in 1 to 4 months. Some patients became anemic. Acid phosphatase levels in serum decreased in patients with prostate cancer after radiohypophysectomy and testosterone administration did not affect the values. It is estimated that with 2 mC of ^{90}Y the radiation dose in a 1 cm dia is ~10,000 rad, which permits destruction of the relatively radiosensitive adenomatous gland. (BBB)

16395 RADIOTHERAPY OF BRONCHIAL CANCER. 5. RADIOTHERAPY OF BRONCHIAL CANCER WITH THE 17-Mev BETATRON. Englaro, G. C.; Vidal, B. (Instituto di Radiologia dell'Ospedale Civile, Udine, Italy). Radiaz. Alta Energ., 3: 41-59(Jan. 1964). (In Italian).

Use of 17-MeV x radiation in the treatment of 124 patients with lung cancer is reported, with data on the side reactions and complications as compared with other types of radiation treatment. This method allows more homogeneous distribution of the dose and, because of the long focal distance, a more localized depth dose, thus sparing healthy tissue. Skin tolerance is increased. Dose-depth curves are compared for 200-kV x rays, ^{60}Co x rays, 17-MeV x rays, 30-MeV β rays, and 31-MeV x rays. A comparison is also made of LET and RBE parameters for the various radiations. Numerous other physical aspects of the radiations are discussed. In the patients treated, 200-rad doses (1200 rad/week) were given to total tumor doses of 6500 rad on the average. The cutaneous reactions were few and practically undetectable. Erythema when it occurred was late in appearing and left only a brown-red pigmentation. In about 10% of the cases, symptoms referrable to radiation disease developed. Some patients experienced a mild esophagitis. Hematologic changes of a severe type were rare, and, in general, the general state of the patient remained good. Early in the treatment course, slight hemoptysis was noted in a few cases, and usually disappeared by the 2nd week. Fever, not a contraindication of treatment, generally abated by the 3rd week. Postirradiation complications varied in relation to the volume of tissue irradiated. Pulmonary fibrosis was evident in a few cases, but appeared to be less frequent than with 200-kV x-ray therapy. Mean survival time of the patients was 10 months. (BBB)

16396 RADIATION RESPONSE AND SENSITIZATION RESPONSE STUDIES IN 720 CASES FROM RADIUMHEMMET, STOCKHOLM. Rubio, C. A.; Kottmeier, H. L.; Olsson, E.; Zajicek, J. (Karolinska Sjukhuset, Stockholm). Acta Cytol., 10: 191-3(May–June 1966).

An evaluation was made in a large patient series of the validity of Graham's RR and SR criteria for predicting results of radiotherapy in cancer of the uterine cervix. The sensitization response (SR) test result was claimed to indicate the radiosensitivity of the host before irradiation of the tumor. Presence of dense, vacuolated parabasal cells (SR cells) in a proportion of 10% or more was considered to be a favorable prognostic sign. In the other test, the radiation response (RR) was measured. It was based on changes exhibited by normal vaginal cells (vacuolization of the cytoplasm, cell enlargement, nuclear changes and binucleation) following irradiation and was considered to be indicative of radiocurability. The association between SR and survival in 449 cases followed up for 5 to 8 yr after radiotherapy was analyzed. Of 95 patients with good SR, only 56.8% were alive at the end of this period. The corresponding figure in the 354 patients with poor SR was 63.3%. It was thus evident that good SR was not associated with cure and was not a reliable index of prognosis. SR apparently was hormone-dependent, since 87% of the patients with good SR values were postmenopausal. Of the 182 patients with good RR, 60.4% were alive at the end of 5 years, and of 256 patients with poor RR, 63.3% were alive. RR thus had no bearing on survival following radiotherapy. Max RR had no bearing on the biologic behavior of the tumors after radiotherapy. It is concluded that SR and RR were not of assistance in forecasting the final results of radiotherapy for cancer of the cervix. (BBB)

16397 CURRENT STATUS OF RADIOTHERAPY FOR NEOPLASTIC DISEASE. Kaplan, Henry S. (Stanford Univ., Palo Alto, Calif.). Disease-a-Month, 1-56(Feb. 1965).

This review (with 35 references) considers the various types of ionizing radiations used, their advantages and disadvantages, dose measurement and distribution, radiotherapy methods, complications, and clinical results. (TCO)

16398 EXPERIENCES IN THE COMBINED CHEMOTHERAPEUTIC AND RADIOLOGIC TREATMENT OF INOPERABLE BRONCHIAL CARCINOMA. PRELIMINARY REPORT. Scholze, Reinhard (Krankenhaus, Blankenburg, Ger.). Deut. Gesundheitsw., 20: 74-8(Jan. 14, 1965). (In German).

Treatment of 49 bronchial carcinoma patients with the cytostatic drug endoxan, given in doses of 400 to 600 mg daily in combination with liver hydrolysates, levulose, vitamin B_6, and ascorbic acid, decreased bone marrow depression and caused increased subjective improvement. Sensitivity to the chemotherapy depended on tumor histology, but with the combined treatment almost all patients showed subjective remission. In combination with irradiation treatment remissions of small-cell carcinomas amounted to one month to a yr. Squamous cell carcinomas responded only to high-energy irradiation. Out of the 49 patients given the combined treatment 24 survived for 1 yr after inception of therapy. Of 8 who were checked for 2 yr 5 survived. Compared to only 30% who survived for 1 yr after receiving only irradiation, 50% of those who received combined treatment survived for at least 1 yr. With all patients the mortality curve showed a very gradually decreasing trend, so that after 6 months 80% and after 9 months ~60% were still alive. (BBB)

16399 RADIOGOLD IN TREATMENT OF OVARIAN CARCINOMA. Dinmore, Richard C.; Kerr, R. Keith; Blake, Clyde D. (Colorado Springs Medical Center, Colo.). Rocky Mount. Med. J., 63: 32-4(Aug. 1966).

A description is given of 34 cases of ovarian carcinoma treated with radioisotopes (^{198}Au and ^{32}P). The techniques of administering the material are presented, data analyzed, complications cited, and results discussed. The routine use of radiogold within 72 hr of surgery is recommended as a practical, relatively safe, and effective therapeutic adjuvant in the primary treatment of ovarian cancer. Radiogold was administered in doses of 200 mCi via a peritoneal catheter. With one exception, a 71-yr-old patient treated for tumor recurrence who suffered aseptic peritonitis and died 1 month after ^{198}Au instillation, there were no serious sequelae and no morbidity other than mild to moderate nausea for 3 to 4 days. Twenty-four of the 34 cases received radioisotopes either alone or in conjunction with surgery and/or radiation therapy. Of 27 of the 34 patients available for 5-yr survival evaluation, 8 survived 5 yr or longer for an over-all 5-yr survival of 29.6%. All the 5-yr survivals were patients whose initial tumors were clinical Stage I or II. Since there were 14 such patients, the 5-yr survival for this group was 57%. There were no 5-yr survivors in the 20 patients with clinical Stage III and IV tumors. In conjunction with the surgery the early use of radiogold or radiophosphorous is both simple and relatively safe. Furthermore, the use of radioisotopes does not necessarily exclude the future use of external radiation or chemotherapy, should either become necessary for tumor recurrence. (BBB)

16400 PROTECTIVE EFFECT OF ORALLY ADMINISTRATED CHLOROQUINE UPON ULTRAVIOLET-INDUCED BIOCHEMICAL CHANGES. Ogura, Rycohei M. (Kurume Univ., Japan). Knox, John M. Jap. J. Dermatol., 74: 68-9(1964).

Young male rats had 0.25 g of chloroquine diphosphate added to each kilogram of their food. After one month of such feeding, the animals were killed. Serum, liver homogenate, and epidermal homogenate were irradiated with a hot quartz broad-spectrum uv lamp. In serum from untreated animals, the usual postirradiation response of both sulfhydryl groups and the polarographic filtrate were seen. The wave height increased in value. Disulfide groups, however, were decreased. In chloroquine-fed animals these changes were appreciably inhibited; disulfide groups actually increased. In samples of nonirradiated epidermis, chloroquine decreased the polarographic protein wave height but did not alter sulfhydryl and disulfide concentrations. After irradiation, all three of the analyzed parameters showed a decrease in values. Chloroquine inhibited the decrease in both sulfhydryl and the filtrate reaction but did not prevent changes in disulfide concentration. An analysis of total sulfhydryl groups revealed that uv irradiation normally lowers or eliminates nonprotein-bound sulfhydryl and that chloroquine provides protection. The drug had no significant effect on protein-bound sulfhydryl. Succinic dehydrogenase activity in liver homogenate was destroyed following uv exposure, with the degree of inactivation being proportional to the length of exposure. Chloroquine administration did not prevent or inhibit the destruction of succinic dehydrogenase. The findings support the contention that chloroquine does not act therapeutically directly as an uv screen by absorbing erythema-producing wavelengths. (BBB)

16401 EFFECT OF VIABILITY OF TRANSPLANTED BONE MARROW ON THE MORPHOLOGY OF HEMOPOIETIC TISSUE OF IRRADIATED RECIPIENTS. Zaitseva, K. K. Arkh. Patol., 28: No. 12, 38-43(1966). (In Russian).

The results of morphological examination of hemopoietic organs of lethally irradiated mice and rabbits to which hetero- and homologous bone marrow was transplanted are presented. Bone marrow transplantation to lethally irradiated animals significantly accelerated the restoration of the myeloid tissue in hemopoietic organs of recipients only in case the donor type cells were viable.

When no cells of the donor type were determinable in the peripheral blood and hemopoietic organs of animals, morphological changes in the recipients' hemopoietic organs failed to differ from those in control animals. Processes of hemopoietic tissue regeneration in the animals-recipients were the most manifest on the 7th–12th postirradiation day. Lymphoid tissue restoration was considerably delayed in comparison with regeneration of the myeloid series of hemopoiesis. (auth)

16402 PROTECTION OF BACTERIOPHAGES CONTAINING SINGLE-STRAND RNA AND DNA FROM RADIATION INJURY. Vinetskii, Yu. P. (Inst. of Biophysics, Ministry of Health, USSR). Mikrobiologiya, 35: 1033-6(1966). (In Russian).

The protective effects of cysteamine for DNA-containing phage fX174 and RNA-containing phage MS2, that are sensitive to E. coli C and E. coli HfrF$^+$, respectively, against indirect gamma-irradiation was investigated. MS2 was found to be more sensitive to radiation than fX174, yet cysteamine in concentrations of 10^{-4} to 10^{-1} M was more effective in protecting the former against radiation. The curve of cysteamine protection of phage fX174 showed saturation at high concentrations of the radioprotective agent. A discussion on the possible mechanisms responsible for the high radiosensitivity of MS2 RNA is presented. (TSS)

16403 PLANNING A RADIOTHERAPY DEPARTMENT. World Health Organ., Chron., 20: 338-43(Sept. 1966).

Various details for setting up a radiotherapy clinic are presented, with emphasis on radioprotection features. The accommodations, in addition to treatment rooms, consulting rooms, and offices, would include a separate operating theatre for the application and insertion of sealed radioactive sources. Unsealed sources constitute a considerable radiation hazard, and their handling demands great care and the following of strict procedures if the contamination of the staff, their clothing, the instruments, and the building is to be avoided. Use of sealed radioactive sources (brachytherapy) poses special protection problems, since when a source is taken from the store it is not possible to limit the dose rate to the max permissible occupational exposure level of 2.5 mrem/hr. The dose rate at 50 cm from a 100-mC radium source is more than 100 times this value. Procedures should therefore be carefully planned to reduce the handling time to a min, and sources should always be manipulated with long-handled instruments and never touched by hand. Wards need protected safes for the temporary storage of sources removed from patients. Sources should be regularly inspected for damage and leakage. Discharge of radioactive waste must be regulated to conform with the requirements of the sewage disposal authorities. The number of discharge points should be limited in order to minimize the spread of contamination and the problems of servicing the drains. Architectural design of the department must make provision for thick heavy shielding for the protection of the staff against radiation. These requirements are best met if the department is a specially built single-story structure, since this avoids the expense of providing protection for the floors above. The erection of permanent radiation-shielding walls made of poured concrete should be avoided, since they are difficult to remove if the need should arise. It is better to construct such shielding of individual chevron-shaped concrete blocks. Establishment of a radiation protection organization is also discussed. (BBB)

16404 THE RESPONSE OF VARIOUS SKIN LESIONS TO ORAL ^{35}S. Applewhite, Mary Lou; McLaren, J. R.; Taylor, W. M. S. Med. J., 59: 1129-33(Oct. 1966).

A new radiation treatment was developed for certain benign skin diseases. It is based on the fact that radiosulfur is highly concentrated in the epidermis, the site of the lesions, and that such local irradiation would be more effective against the lesions and sparing of normal tissues than external radiotherapy. Many skin diseases respond well to radiation therapy, but generalized radiation to the total body may produce severe symptoms even in low dosage. The first patients were treated for mycosis fungoides. When the results obtained on these patients were favorable, the study was expanded to include 13 patients with other skin diseases. If ^{35}S is to be used in the treatment of generalized skin diseases, it must not only produce regression of these lesions but must also be sufficiently localized to these lesions so its effects elsewhere in the body are minimal. Autoradiographs of the skin and of lesions, the lack of appreciable drop in blood counts, and the turnover rates of radioactivity in the blood and urine specimens suggested that these latter criteria are met. In mycosis fungoides the clinical response indicated adequate localization of the radioactivity to the lesions. Blood counts in only one case showed an appreciable drop. Two patients who received 30 mCi 3 times in a 6-week period showed no appreciable drop in blood counts. Initially the blood radioactivity disappearance rate was slow. The half-time for the first slope of this curve was 12 hr and for the second portion 5 to 7 days. The dose to the bone marrow should be 0.255 rad per mCi, or, in the patients treated, 7.5 rad per 30-mCi dose. (BBB)

16405 GUIDELINES FOR DENTAL CARE WHEN PATIENTS RECEIVE RADIATION THERAPY TO THE HEAD AND NECK. Bottomley, William K.; Ebersole, John H. (National Naval Medical Center, Bethesda, Md.). Oral Surg., Oral Med., Oral Pathol., 22: 252-6(Aug. 1966).

Prevention of radiation reactions in healthy tissues after oral radiotherapy, and their treatment when they do occur, is discussed. It is recommended that all pathologically involved teeth that might require removal in the next 12 to 24 months should be extracted. Any alveolar bone exposed at the time of surgical intervention should be eliminated. Irradiation can begin on the day following extraction without causing any observable delay in healing. All teeth to be retained should be in a good state of repair and relatively free of periodontal disease. Pointed cusps and sharp edges of restorations and prosthodontic appliances should be smoothed and polished. The patient should be made to understand that he will experience a dry mouth or a decreased flow of saliva but that he can make this condition less unpleasant by taking frequent sips of water. He should be given explicit, detailed instructions in oral hygiene. The necessity of meticulous care of the teeth and their supporting structures should be stressed. He should be instructed in methods of reducing irritation to the oral mucosa caused by the radiation. He should be advised to refrain from the use of tobacco, alcohol, hot foods, and astringent mouthwashes. Instead of the latter, the frequent use of warm saline mouth rinses will moisten the tissue and reduce its hypersensitivity. The most frequent postirradiation signs and symptoms are dry mouth, stomatitis, hypersensitivity of the mucosa and teeth, and cervical carious lesions. Frequent oral examinations should be made so that any undesirable changes in the condition of the oral mucosa, the teeth, and their supporting structures can be intercepted at an early stage and treated accordingly. (BBB)

16406 TRACKING COBALT PROJECT: A NEW METHOD OF TREATING CANCER BY RADIOTHERAPY. Green, Anthony (Royal Northern Hospital, London). Nursing Times, 62: 1086-8(Aug. 19, 1966).

Recently developed automation techniques for rotating beam telecobalt radiotherapy, whereby cancer cells receive a max radiation dose and healthy tissues are spared, are reviewed. Rotation therapy allows the radiation dose to be spread out over a large zone of healthy tissue while concentrating on the tumor at the center. By firing from an increasing number of circular positions, the damage produced may be so slight at the edges as to be almost unnoticeable clinically. This is called moving beam radiotherapy. The automated equipment used to achieve these conditions is described and illustrated. Radiotherapy is not limited by vital structures but is restricted by sensitive structures. The extent of damage is reduced by greater accuracy and spread in delivery of radiation. In cervical cancer the pathway of lymph node spread starts near the cervix and winds upwards in the abdomen, twisting in two planes. With the routine type of radiotherapy this must be covered by one large radiation field. The tracking telecobalt method enables the track only to be irradiated. Data fed into the tracking mechanism control the track of the beam, its speed of movement, and the beam size. This is accomplished by variations in speed and shutter size, during irradiation, of the head source. Such automation provides a more accurate treatment of a defined and limited volume of the body. This has two main advantages. First, as the volume is smaller, much less tissue is exposed to damage and the complication rate is lower. Secondly, as small volumes of tissue have greater tolerance to radiation, the local dose can be increased so that the cure rate increases. (TSS)

16407 SPLIT-DOSE RADIOTHERAPY. Scanlon, Paul W. (Mayo Clinic, Rochester, Minn.). Progr. Clin. Cancer, 2: 143-63(1966).

Radiobiologic basis of the split-dose irradiation technique is explained, and its use to achieve increased survival rates and to lower unwanted irradiation effects is described. In addition to the effectiveness of such therapy as judged in terms of 5-yr cancer arrest rates, there are additional advantages to the use of split-dose therapy. It can be administered with a considerable reduction in radiation morbidity. Especially in the aged, infirm, debilitated, or those whose general condition is seriously jeopardized by coexisting medical complications, the easier, much gentler course of the patient undergoing divided-dose radiotherapy has been proven. (TSS)

16408 EXPERIENCES WITH ELECTRON IRRADIATION OF MALIGNANT TUMORS IN THE HEAD AND NECK REGION.

Bauer, Robert; Schoen, Detlev (Univ., Tuebingen, Ger.). Strahlentherapie, Sonderbaende, 62: 25-43(1966). (In German).

Out of a series of 205 patients irradiated with fast electrons having energies from 8.9 to 16.5 MeV, where no additional radiation or cytostatic drugs were given, only two gave subjective evidence of any general reaction to irradiation. In both of these cases the average daily dose was from 222 to 334 R and the total dose was from 4000 to 8000 R. The frequency was 2.2% after irradiation of the body. Leukopenias were observed in 3 of 73 patients irradiated with electrons of the same energy over periods of 18 to 32 days with 6300 ± 3000 R. In 4 out of 71 patients who received one or several irradiation series with 12.4 ± 4.2 MeV electrons with 6200 ± 3000 R and 5200 ± 2000 R at intervals of 3.7 ± 1.8 months leukopenia was observed. In several other patient series the frequency of leukopenia observed was 12.5%, as compared with an 8% frequency seen with x-irradiation. Skin tolerance is much greater for energetic electrons than with x-irradiation. With no previous exposure, slight erythema, severe erythema, and exudative dermatitis are observed with average doses of 3900 ± 1300 R, 4100 ± 930 R, and 4500 ± 960 R of energetic electrons respectively. Pre-exposure to one or more electron irradiation series gives similar skin reactions from energetic electrons at 3600 ± 1050 R, 3900 ± 1170 R, and 4200 ± 1100 R, respectively. After preirradiation with x rays, the corresponding values are 3500 ± 1330 R, 4000 ± 1670 R, and 4200 ± 1910 R. Epitheliolysis is increased by irradiation with electrons of 12 MeV or more. (BBB)

16409 A COMMERCIAL ENCAPSULATED DESICCANT FOR USE IN SLIDE CONTAINERS DURING AUTORADIOGRAPHIC EXPOSURE. Sikov, Melvin R. (Battelle-Northwest, Seattle, Wash.). Stain Technol., 40: 239(July 1965).

An improved step in autoradiography was introduced by using a desiccant that does not produce artifacts. In various other techniques for achieving low humidity by enclosure of the drying agent in containers or exposure chambers, it was found that microscopic particles of desiccant settling upon the emulsion create artifacts. To obviate this difficulty, the use of an encapsulated desiccant (Humi-caps) available commercially for use in the food packing industry, was investigated. It was found that these capsules, which contain ~1 g of desiccant, absorb ~50 mg of water when left in the open under moderately dry lab conditions. When placed in an atmosphere of 100% humidity, they imbibe as much as 250 mg of water. The desiccant is colored with a blue indicator that turns pink as the desiccant becomes saturated. Ordinarily, three of these capsules, placed at one end of a 25-slide plastic slide box, are sufficient to maintain low humidity under average conditions, but if dark-room humidity is particularly high, 3 or 4 capsules should be placed at each end of the box. The technique produces results, as measured by grain density, which is equivalent to those obtained by more elaborate techniques. Moreover, autoradiographs were completely free of artifact due to dust settling upon the emulsion. (BBB)

16410 RADIOACTIVE TRACER METHODS IN CLINICAL MEDICINE. Belcher, E. H. (Postgraduate Medical School, London). Sci. Basis Med., Annu. Rev., 250-75(1964).

A review of recent advances in medical diagnostic uses of radioisotopes includes the following topics: production of artificial radioisotopes and labeled compounds, methods of measurement of isotopes, limitations of tracer techniques, isotope dilution analysis, turnover studies, scanning techniques, and saturation analysis. Radiation hazards associated with radioisotope diagnostic procedures are outlined. In a discussion of the radiation dose received by the patient, the concept of the critical organ is introduced, being defined as the organ which receives the highest radiation dose or is most likely to suffer radiation injury as a result of the test under consideration. It is suggested that a rational reassessment of the problem of permissible doses of radioisotopes in clinical procedures and the establishment of internationally accepted standards of practice are long overdue. In the meantime, it is wise to use every means to reduce exposure to radiation in such procedures, especially in children, young adults, and pregnant women. Ways by which this may be achieved are enumerated. (TSS)

16411 GENETIC AND SOMATIC RADIATION EFFECT WITH PARTICULAR REGARD TO USE OF RADIATION DURING PREGNANCY. Schinzel, A. (Univ., Innsbruck). Mitt. Oesterr. Sanitaetsverwalt., 66: 159-64(May 15, 1965). (In German).

The irradiation burden imposed by naturally present radiation, including that from external and internal sources, is listed and totaled. In addition, the estimated amounts of irradiation received by humans over periods of 30 yr from technical sources are compiled. These are compared with the possibilities of their hereditary effects on human offspring. Examples of studies made on females who received, on an average, 1860 R of x irradiation in the region of the ovaries prior to pregnancy and on males who had also been irradiated are described. The results indicated a lethal mutation rate of 8.0×10^{-5}, indicating that exposure to 1 R would result in ~9 stillborn offspring per 100,000 births. This does not take into account the possibility of other irradiation effects on chromosomes. As the fetus develops, the sensitivity of the embryo toward radiation effects that may cause death gradually decreases. During the stages of organogenesis, fetal malformations and disturbances in development may be produced by irradiation. In general, the type of injury induced is related to the stage of organogenesis, the amount and rate of irradiation, and the type of radiation. The most sensitive organ seems to be the eye. Disturbances in the development of the heart and skeleton are also frequent. Disturbances of the central nervous system are less frequent. The effects of irradiation on embryos indicate the absolute necessity of protection of pregnant women by proper shielding and minimizing exposure as much as possible. (BBB)

16412 LASER SURGERY OF MALIGNANT TUMORS. McGuff, Paul E.; Deterling, Ralph A. Jr.; Gottlieb, Leonard S.; Fahimi, H. Dariush; Bushnell, David; Roeber, Fred (Tufts-New England Medical Center, Boston). Dis. Chest. 48: 130-9(Aug. 1965).

A comparative study of the effectiveness of laser energy treatment with irradiation (1000 R) was performed on adenocarcinomas of human origin transplanted into hamster cheek pouches. The laser-treated group with adenocarcinomas showed progressive regression of the tumors upon gross examination during the first four weeks and complete dissolution of the tumor at the fifth and sixth week. Histologic examination of excised cheek pouch specimens at weekly intervals showed tumor cells remaining in each specimen during the first four weeks, but no tumor cells were seen upon histologic examination of the specimen at the fifth and sixth weeks. This group received an average of 214 J of laser energy per tumor. The x-irradiated group showed increase in growth of the tumors upon gross examination at weekly intervals and no destruction of tumor cells upon weekly histologic examination. The effect of laser energy on human myxofibrosarcomas in the cheek pouch of hamsters was also evaluated. Laser-treated cheek pouches were completely free of tumor grossly between the 7th and 60th post-laser day with an average of 29 days. Total laser energy utilized ranged from 50 to 550 J, with an average of 229 J per tumor. (BBB)

16413 LATE EFFECTS OF RADIATION IN RELATION TO CANCER IN JAPAN. Angevine, D. Murray (Univ. of Wisconsin Medical School, Madison). CA, Med. J., 14: 16-17(Jan.-Feb. 1964).

Autopsy studies at the Atomic Bomb Casualty Commission at Hiroshima and Nagasaki are briefly reviewed. These studies are now largely concerned with delayed radiation effects in a population sample of ~100,000 exposed and nonexposed persons controlled as to age and sex from both cities. A sufficient number (1215) of autopsies has been performed to show what effect, if any, the degree of exposure may have had upon different disease groups, with special emphasis being given to various kinds of malignant tumors. Results of the pathology study from October, 1950, to September, 1962, revealed that malignant tumors of the stomach, lung, uterus, liver, colon, and thyroid were frequent but no significant increase of these neoplasms was demonstrated among proximally exposed persons. In thyroid glands, intensively examined at autopsy, seven of 21 malignant lesions were observed in patients in the closely exposed group (within 1400 m). Most (18) of these lesions were microcarcinomas. Leukemia in the autopsy series again exhibited an association with prior irradiation, 19 of 32 cases being in persons within 1400 m. Other malignancies of the lymphatic system slightly exceeded the expected number but not significantly. Myelofibrosis was also increased when compared with other parts of Japan and showed a definite relation to distance from the hypocenter. When all malignancies, excluding leukemia, were considered as a group, 61 of 418 occurred in survivors exposed within 1400 m in contrast to an expected number of 56.8, which is easily explainable on sample variation. No relation to exposure was evident for other principal diseases. (BBB)

16414 RADIOTHERAPY OF BRONCHIAL CANCER. 2. HISTOPATHOLOGIC REPORT OF IRRADIATED BRONCHIAL CARCINOMA. Calzavara, F.; Tosi, G. (Univ., Padua). Radiaz. Alta Energ., 3: 4-10(Jan. 1964). (In Italian).

Histologic changes in 20 cases of bronchial carcinoma following radiotherapy are described. Local doses of 4000 to 6000 RAD were administered, and tumor specimens were obtained at autopsy, a few days to two yr after treatment. Tumors examined soon after treatment usually showed regressive changes, including vacuolation of cytoplasm and nuclear pyknosis. In some cases there was a complete absence of mitotic figures in tumor cells. In patients given lower doses (~4000 RAD) necrobiotic processes

were evident, with a tendency toward fusion of tumor cells. The stroma of the tumor showed infiltration by cells of the lymphocyte-plasma cell type, associated with proliferating fibroblasts producing dense bundles of connective tissue fibers, subsequently transformed to hyaline. Blood vessel walls in the tumor vicinity often showed injury, ranging from damage to the endothelium to complete occlusion of the vessel. The envelopment of surviving tumor cells by avascular hyaline tissue appeared to compromise their metabolic activities; destruction or occlusion of blood vessels was involved in this phenomenon. (BBB)

16415 RESULTS AND EXPERIENCES IN THE DESTRUCTION OF THE PITUITARY GLAND. A. RESULTS OF THE VIENNA TEAM. Beringer, A.; Burian, K.; Ellegast, H.; Frey, R. G.; Frischauf, H.; Zeitlhofer, J. (Univ., Vienna). Bibl. Otorhinolaryngol., 12: 160-84(1965). (In German).

The authors report results of various methods of extirpation of the hypophysis, including implantation of radioisotopes. They utilized both ^{198}Au and ^{90}Y, but found that only 30 to 50% of the hypophysis was destroyed by ^{198}Au, but that 90% was destroyed by ^{90}Y. The complication most frequently observed was formation of fistulas causing spinal fluid leakage. The incidence was 20% after ^{90}Y use. Spontaneous healing was rare and surgery usually was required. Because of this complication, radioisotopic extirpation of the hypophysis was largely discontinued and surgical procedures substituted. Objective remission of symptoms was observed in only 15% of the cases after ^{198}Au was used, and in 30% of the cases after ^{90}Y was used. Surgical hypophysectomy was more successful in decreasing symptons in the cases for which it was used. These largely included metastatic mammary and prostatic carcinomas and diabetic retinopathy, but hypophyseal extirpation was used also for alleviation of symptoms of several hormone independent carcinomas, acromegaly, and myeloblastic leukemia. (BBB)

16416 ORGANIC DISULFIDES AND RELATED SUBSTANCES. XVII. ANALOGS OF o-(2-AMINOETHYLDITHIO)BENZOIC ACID AS ANTIRADIATION DRUGS. Field, Lamar; Kim, H. K. (Vanderbilt Univ., Nashville). J. Med. Chem., 9: 397-402(May 1966).

o-(2-Aminoethyldithio)benzoic acid (I) gives good protection against lethal effects of ionizing radiation, but several derivatives or isomers of I do not (e.g., the ester, the N-acetyl and N-(n-decyl)amino derivatives, and the meta or para isomers of I). Synthesis of ortho-substituted analogs of the presumed zwitterion I in which the carboxyl group was replaced by other groups was carried out. These analogs were prepared by thioalkylating thiols with thiosulfonates. Activity was not confined to a zwitterionic structure typified by acid I, since replacement of CO_2H by Cl, CH_3O, or $HOCH_2$ gave active compounds, but the most promising analogs were zwitterions in which the HO_2C of I was replaced by HO_3S (II) or the 2-aminoethyl moiety by 2-pyridylmethyl (III); both II and III were rated radioprotective agents. Resistance of the unsymmetrical disulfides prepared to disproportionation into symmetrical one differed for thermally and photochemically induced reactions. The ortho substituents had marked but unpredictable effects. Three of the nonzwitterionic ortho analogs were active, but were only fair radioprotectants. There were no striking correlations between protective activities and either electronic effects of the ortho substituents or resistance of the disulfides to disproportionation. Nevertheless, the ortho substituent obviously plays a highly significant role, even though an unpredictable one, in both protective activity and resistance to thermally or photochemically induced disproportionation. (BBB)

16417 TREATMENT OF POLYCYTHAEMIA VERA. Brit. Med. J., 2: 186-7(July 23, 1966).

Complications of ^{32}P treatment, especially leukemia, are reviewed and compared with those resulting from chemotherapy. In one series of 127 patients observed for 25 yr the average survival of the patients was the same with drug therapy as that found with ^{32}P, or about 13 yr. Nevertheless, chemotherapy was more troublesome for both patient and doctor; much closer control was needed than with ^{32}P, regular attendance for blood counts was necessary for adjustment of the dose, and all the drugs had more troublesome side-effects than radiophosphorus. But no case of acute leukemia occurred in this series. Since leukemia is now known to be one of the possible results of therapeutic exposure to radiation, it has become important to consider how far leukemia as a terminal phase of polycythemia is due to treatment with radiophosphorus. The records of 1222 patients showed that acute leukemia occurred in 11% of patients treated with radiophosphorus and in 8.9% of patients treated with x rays, indicating that the incidence was related to the total dose of radiation received. One case of acute leukemia was found among 107 patients treated with ^{32}P. A later study showed 11% hematological complications in 169 patients treated with radiophosphorus; four had acute leukemia, 12 had myelosclerosis, and two developed depression of bone marrow. The practical effect of all this data on the management of polycythemia has been to show that both radiophosphorus and chemotherapy may be used for treatment. Radiophosphorus has some advantages despite the risk of leukemia; this risk is small and sometimes worth accepting, especially for older patients. On the other hand, the recognition of the risk should strengthen the case for the use of chemotherapy in the relatively few patients who develop the disease below the age of 50 yr. (BBB)

16418 ON THE ROLE OF PHOTOPRODUCTS OF TYROSINE AND TRYPTOPHAN IN THE ORIGIN OF ACTINIC CARCINOMA IN THE WHITE MOUSE. Wetzel, R.; Hoffman, F.; Lindigkeit, R. (Medizinisch-Biologisches Forschungszentrum, Berlin). Arch. Geschwulstforsch., 20: 85-95(1963). (In German).

The question has been raised whether carcinogenic substances responsible for formation of tumors are produced photochemically from tyrosine or tryptophan by uv irradiation of animals. Evidence for several additional components of solutions originally containing these amino acids has been shown following irradiation at pH 7.2 with doses of uv light from 1.7×10^9 to 2×10^{10} erg/cm^2. Uv-irradiated tyrosine or tryptophan was injected subcutaneously into mice and other groups of mice were uv-irradiated directly and injected subcutaneously with amino acids. The total uv irradiation of the amino acids used was 6.9×10^9 erg/cm^2. The animals received cumulative doses over a one-yr period of $\sim 90 \times 10^9$ erg/cm, distributed almost equally over the months. The irradiated animals soon developed acute inflammation of the skin, necrosis of the epithelium and hair follicles, and cell proliferation and vascular dilatation in connective tissue. Hyperregeneration epithelial thickening was observed later. The hair follicles and glands become largely atrophied. There was connective tissue proliferation in the subcutis. Within 4 to 5 months after beginning of irradiation there was increased epidermal hyperplasia with formation of epithelial tenons that invaded the connective tissue. The connective tissue became extensively proliferative, and 12 months after beginning of the irradiations a skin tumor appeared at the site of epilation. This was a spindle cell sarcoma. After subcutaneous injection of uv-irradiated amino acids no tumors were observed. A number of tumors were observed in animals that received tyrosine or tryptophan in conjunction with uv irradiation, which amounted to between 45 and 55×10^9 erg/cm^{2}m given over a period of ~ one yr. The incidence of actinic tumors in the mice indicated that they were not due to a photochemical formation of cancerogenic substances from tyrosine or tryptophan, but were probably due to structural changes of cell materials induced by the uv irradiations administered. (BBB)

16419 STUDIES OF THE MECHANISM OF ULTRAVIOLET ERYTHEMA FORMATION. II. THE EFFECT OF AN INCREASED AND A REDUCED SEROTONIN CONTENT OF EXPERIMENTAL ANIMALS. Valtonen, Erikki J. (Univ. Central Hospital, Helsinki). Acta Dermato-Venerol., 46: 288-91(1966).

Development of erythema in the ear skin of mice exposed to long wavelength (uv-B) and short wavelength (uv-C) radiation was studied. Animals of the first group were injected with 5 mg/kg of reserpine once a day for 2 days before uv irradiation. Animals of the second group were similarly injected with 100 mg/kg of serotonin, and mice in the third group with 10 mg/kg of β-phenylisopropylhydrazine hydrochloride (PIH or JB-516), a potent and long acting monoamine oxidase inhibitor, once a day for 3 days before uv irradiation. The fourth group was a control. Each of the 4 groups were further divided for irradiation with uv-B or uv-C. Irradiation lasted 10, 11, and 13 sec for uv-B, and 1, 2, and 3 min for uv-C. In the control group the first irradiation dose (10 sec with uv-B and 1 min with uv-C) caused slight erythema. The erythema values in the reserpine group in both wavebands were lower than in the control group. The values in the serotonin and PIH groups were slightly higher than in the controls. All these changes, however, were statistically insignificant; the most striking difference found was the difference between animals irradiated for 1 min with uv-C in control and reserpine groups. The results indicate that changes in the serotonin content of the animals had no effect on erythema formation. (BBB)

16420 LEAD-SHIELDED CABINET FOR USE IN X RAYING RATS. Pyke, Ralph E.; Stover, B. J. (Texas Woman's Univ., Denton). Lab. Animal Care, 16: 292-3(June 1966).

A cabinet was designed to enclose a rat during diagnostic irradiation so that the investigators are shielded from the radiation without the necessity of moving behind a lead shield before each exposure. The cabinet consists of a wooden box, the base of which is 20 in. square and 32 in. high. The height is such that the entire floor of the cabinet is exposed to x rays when the instrument is turned on. On one side is a hinged door of

sufficient size that an 8 × 10 in. film may easily be placed inside. On another side is a lead glass window so that the rat may be observed during the exposure. A hole was cut in the top and the x-ray tube mounted over it. The entire inner surface of the cabinet was covered with lead of sufficient thickness to absorb any radiation which might strike it. To obtain the greatest contrast in radiographs of the rat to be used for the assessment of skeletal maturation, the aluminum filter which was built into the head was removed. (BBB)

16421 CERVICAL CARCINOMA IN PREGNANCY. Stone, Martin L.; Weingold, Allan B.; Sall, Sanford (New York Medical Coll., N. Y.). Amer. J. Obstet. Gynecol., 93: 479-85(Oct. 15, 1965).

Problems encountered in treating 64 pregnant patients with cervical cancer by radiation are described, particularly as concerns protection of the fetus and birth of a deformed infant are reported. In the first trimester, Stage I lesions are treated by radical hysterectomy and pelvic lymphadenectomy. Stage II, III, and IV lesions in the first trimester are treated by external radiation followed by intracavitary and colpostat radium application. The external radiation usually results in spontaneous abortion between 3 to 8 weeks after therapy. External radiation first is preferred to reduce the possibility of tumor embolization resulting from cervical manipulation at the time of curettage and radium insertion. The abortus that is passed following radiotherapy causes minimal cervical dilatation and effacement. In the second trimester, for Stage I lesions, radical surgery is performed. For more advanced stages, hysterotomy is performed followed in one week by external radiation with shielding of the healing wound. Subsequently radium is applied. Hysterotomy avoids the delivery of a possibly abnormal baby following radiation therapy in the rare instances in which pregnancy continues. One late second trimester patient, treated by radiation therapy without hysterotomy, produced an infant with microcephaly, bilateral congenital hip deformity and aplastic anemia. About 20% of viable fetuses delivered after radiotherapy are microcephalic. In the third trimester, radiation therapy is started on the seventh postpartum day. (BBB)

16422 UTILIZATION OF CYCLOPHOSPHAMIDE TO POTENTIATE TUMOR DESTRUCTION BY LASER ENERGY. Minton, John Peter; Ketcham, Alfred S. (National Cancer Inst., Bethesda, Md.). Surg. Forum, 16: 113-15(1965).

A new approach to increase the destructive capability of laser energy was tested. It involves the utilization of chemotherapy in conjunction with the application of pulsed laser energy. Four groups of female CD mice with a single subcutaneous implant of the highly malignant Cloudman S91 melanoma were studied. Tumors in group 1 were exposed to varying amounts of ruby laser energy at 50 J per pulse depending on the size of the tumor. Animals in group 2 were given a daily injection of cyclophosphamide (25 mg/kg) for 11 days. On the sixth day of chemotherapy, each tumor was exposed to an amount of laser energy similar to the amount given tumors of the same size in group 1. Mice in group 3 received only chemotherapy, and mice in group 4 received no therapy. In group 1 only 3 of the 14 tumors were permanently destroyed; the largest measured 3 mm in dia. Twelve of 16 tumors in group 2 were permanently destroyed; the largest measured 12 mm. Tumors in group 1 and 2 that were not destroyed eventually killed their host, as did all tumors in groups 3 and 4. Cyclophosphamide when used in conjunction with pulsed ruby-laser energy thus significantly potentiated the oncolytic capability of the ruby laser for this Cloudman S91 melanoma tumor system. Apparently, the presence of this alkylating agent potentiates the destructive interaction of laser photon energy on intracellular enzyme systems which results in cell devitalization. (BBB)

16423 MODIFICATION OF THE RADIATION PROTECTIVE EFFECT OF OLIVE OIL BY VARIOUS APPLICATION METHODS AND COMBINATION WITH A PLANT EXTRACT. Locker, A. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Naturwissenschaften, 53: 612-3(1966). (In German).

The survival of white mice exposed to a lethal x radiation dose (800 R) after treatment with olive oil alone and in combination with the plant extract Helenien was studied. The mice received intraperitoneal injections of olive oil followed 15 min later by irradiation, injected with olive oil and Helenien in combination followed by irradiation one fourth hour later, injection of olive oil alone for 14 days followed by irradiation, and olive oil plus Helenien in combination for 14 days followed by irradiation. The survival of the mice was followed for 30 days. The results showed that olive oil alone injected immediately before the irradiation had practically no protective effect. Olive oil plus Helenien followed immediately by irradiation increased the protective effect significantly in comparison with the olive oil but the protective effect was much less than that obtained with the 14 day treatment with olive oil and with olive oil plus Helenien. (J.S.R.)

16424 SOFT X IRRADIATION OF CERTAIN SEBORRHOIC WARTS. Storck, H.; Schwarz, K. (Dermatologische Univ., Zurich). Dermatologica, 133: 40-9(1966). (In German).

The use of x-ray therapy for benign skin diseases is discussed from the point of view of the possible hazards as weighed against the beneficial esthetic effects to be obtained. The local radiation reactions in skin are also described. Radiotherapy of seborrhoic warts should be considered only in certain exceptional cases, especially in older people presenting very widespread lesions and complaining of severe pruritus. Twelve patients were treated with soft (50-kv) x rays during the past 6 yr. In fractionating the doses, it was necessary to give 5 × 400 or 4 × 500 R to obtain satisfactory regression of the seborrhoic warts using the large field technique and irradiation at a distance of 40 to 100 cm. The same doses were useful for smaller fields treated with softer x rays, 12 or 30 kV. The necessity of exact doses and good irradiation technique is stressed. The radiation reaction in skin was generally noted 2 to 6 weeks following completion of therapy, generally as moderate erythema. Only in one case did intense reddening of the skin, accompanied by a neurogenic reaction, occur. Increasing pigmentation of the skin developed over several months. Residual changes in the skin, which were few, are also described. (BBB)

16425 PRESERVATION OF BLOOD AND BONE MARROW AT SUB-ZERO TEMPERATURES. Pegg, D. E. (Westminster Hospital, London). Lab. Practice, 15: 405-9(Apr. 1966).

The use of frozen bone marrow for infusion in irradiated donors is discussed preliminary to a description of the techniques used in bone marrow preservation. Animals subjected to lethal total-body irradiation may recover if given infusions of sufficient quantities of compatible bone marrow cells. The infused marrow cells recolonize the marrow spaces denuded by the irradiation, and may lead to the restoration of hemopoiesis. Animal experiments have led to the use of bone marrow transfusions in human subjects who have been irradiated, either therapeutically or accidentally. For this purpose large quantities (200 to 400 ml) of marrow are needed in a sterile condition. In early techniques slow freezing of marrow in 15% glycerol with storage of samples at −79°C was used, and subsequent investigations have shown this process to be extremely efficient. The freeze-stored marrow is just as effective in securing the recovery of irradiated animals as is fresh marrow. Other protective agents used for bone marrow preservation are dimethylsulfoxide (DMSO) and polyvinylpyrrolidone (PVP). Although bone marrow preserved with DMSO was found to be no better in securing the survival of irradiated mice than glycerol-preserved marrow, the rate of hematologic recovery of the recipient animals was increased. In the first use of PVP to protect rat bone marrow cells, it was claimed that it is less toxic than glycerol or DMSO and that it gives 80% of the recovery rate obtainable with glycerol, but other workers have failed to confirm these findings. In view of the uncertainty of the relative merits of PVP and DMSO, and also because of the obnoxious odor emitted by recipients of infusions containing significant amounts of DMSO, glycerol is still used for clinical bone marrow preservation. (BBB)

16426 STUDIES OF THE SURGICAL APPLICATIONS OF LASER (LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION). McGuff, Paul E.; Bushnell, David; Soroff, Harry S.; Deterling, Ralph A. Jr. (Tufts-New England Center Hospital, Boston). Surg. Forum, 14: 143-5(1963).

Biological effects of laser radiation were studied in human and animal tissues with ruby lasers with from 0.5 to 360 J energy output and a simple optical system for focusing. The beam was emitted for 0.5 to 3 msec. When arteriosclerotic plaques in the abdominal aorta and coronary arteries were exposed to a single dose of 10 to 13 J, atheromatous plaques were affected more than the calicific plaques. When solid hepatic metastatic nodules, adjacent normal liver, and primary lung and gastric tumors were exposed, local destruction of the tumor tissue was significantly greater than that observed in the adjacent normal tissue. There was a clear area of demarcation between the treated and untreated areas. A Pitt-41 malignant tumor of human origin, treated with 2 doses of 130 J each, after 14 days, was eradicated completely. Transplanted fibrosarcomas, originally induced by methylcholanthrene, in the flank of hamsters did not respond so well, but showed gross pathologic and microscopic destruction of from 60 to 80%. Laser radiation destroyed one half of the malignant melanomas in the cheek pouch of hamsters which were also evaluated. It appears that the laser has a selective effect upon tumors, since the treated tumors were destroyed while the ad-

jacent normal tissue was relatively unaffected. The effects of the laser appear to be both immediate and delayed. (BBB)

Radiation Effects on Animals

Refer also to abstracts 16286, 16316, 16317, 16354, 16356, 16371, 16373, 16384, 16397–16399, 16405, 16415, and 16424.

16427 (AD–638917) INVESTIGATION OF THE EFFECTS OF RUBY LASER RADIATION ON OCULAR TISSUE. Jacobson, Jerry H.; Najac, Harold W.; Cooper, Blossom (New York Eye and Ear Infirmary, New York). June 1966. Contract DA-36-038-AMC-685(A). 34p. CFSTI $3.00 cy, $0.65 mn.

A series of laboratory and field experiments on rabbits were conducted in order to establish tentative safe operational distances and conditions for use of the Frankford Arsenal XM23 Laser Rangefinder. The measured far field corneal threshold dose for rabbits was tentatively determined to be 5×10^{-7} J/cm^2. From this a possible human corneal threshold was calculated as 1.45×10^{-6} J/cm^2. Based on this value, tentative safe operational distances were calculated as being 6460 m for night (8 mm pupil), 1615 m for twilight (4 mm pupil), and 914 m for daylight (3 mm pupil). (auth)

16428 (LA-DC–8110) RADIATION RESPONSES OF MAN IN THE INTERMEDIATE DOSAGE RANGE. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 10p. (CONF-661001–43). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Occurrence of early and late radiation effects in man is considered in relation to dose. Studies of early effects indicated that: skin erythema and desquamation appear in about 50% of the cases after doses of 550 to 650 rad; the LD_{50} of prodromal reactions are induced by doses in the range of 100 to 200 rads; blood count depressions are induced by exposure to marrow doses of 100 to 200 rads of γ or x rays; the LD_{50} in man is about 300 rads measured at the approximate midline of the body; and doses of about 600 rads are required to produce permanent sterility. Minimal permanent or late skin changes accompany all high-intensity radiation doses that produce an early moist desquamation reaction and usually consist of slight changes in skin texture, telangiectasia, and slight pigmentary manifestations. The dose of high-intensity x radiation for production of about 50% probability of necrosis appears to be about 2500 to 3000 rads, and a single dose of about 750 to 800 rads is associated with a probability approaching unity for production of permanent lens changes. Observations of the Japanese atomic bomb survivors and people exposed for medical purposes suggest that the increase in leukemia incidence is proportional to accumulated dose (above 100 to 300 rads), and that the best estimate of risk from penetrating x- or γ-ray exposure is about 1 to 2 chances/10^6 man-years/rad for protracted or fractionated exposure and 3 to 4 chances/10^6 man-years/rad for single high-intensity exposure. Retrospective studies of medical radiologists and observations of irradiated animal populations suggest that the life-shortening risk in man from whole-body protracted or fractionated x-ray exposure may be 2 to 3 days/rad measured at the approximate midline of the body. (H.G.D.)

16429 (N–66-33446) AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES, JUNE 1966. (National Aeronautics and Space Administration, Washington, D. C.). July 1966. 196p. (NASA-SP–7011(26)). CFSTI $3.00 cy, $0.65 mn.

An annotated bibliography with indexes is presented to serve as a current abstracting and announcement medium for references on aerospace medicine and biology. Subject coverage includes biological, physiological, psychological, and environmental effects on man during and following simulated or actual flight in the earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors are considered. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development are also recorded. (STAR)

16430 (RM–5141-TAB) SENSITIVITY OF MORTALITY ESTIMATES TO VARIATIONS IN AGGREGATE POPULATION REPRESENTATIONS. Goeller, B. F. (RAND Corp., Santa Monica, Calif.). Dec. 1966. Contract AT(04-3)-414. 85p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Changes that occur in estimates of mortalities from prompt effects, fallout, and combined effects with changes in the population representation used for damage assessment are reported. Representations for the U.S. population are created by laying a square mesh grid of some particular dimension over the United States and adding up the population contained within each cell. Different population representations are made from different size grids, the size of the grid indicating the population representation's degree of aggregation. The study considers U. S. population representations with grid sizes of 5, 10, 20, and 50 km. Two hypothetical attacks are employed: a low-collocation attack and an indiscriminate attack (i.e., unrestrained targeting). The mortality estimates are computed by Quick Count, the RAND mortality estimation model. For the low-collocation attack, the estimated mortalities are insensitive to a change from 5 to 10 km in the population representation's grid size. But a change from 5- to 20-km grid reduces the estimate of mortalities by more than 3 million, and a change from 5- to 50-km grid reduces the estimate by almost 18 million, about 16 percent. Yet, for this attack, the change in grid size from 5 to 50 km has less effect on the mortality estimates than the two levels of shelter considered (roughly comparable to a house and a minimally effective basement shelter) or the two extreme (for this attack) wind patterns selected. The variation in the estimate that comes from changing the grid from 5 to 50 km is, at most, comparable to the variation from the change in fallout protection and roughly half that from the change in winds. For the indiscriminate attack, the mortality estimates are sensitive even to a change from 5- to 10-km grid, which reduces the estimate by nearly 1.5 million. A change from 5 to 50 km reduces the estimated mortalities by approximately 25 million, more than 25 percent. This variation is about double that from the change in the winds. For both attacks, there is a general trend that mortality estimates decrease as the grid size (degree of aggregation) of the population representation increases. (auth)

16431 (USNRDL-TR–67-2) APPLICATION OF PREMACK'S THEORY TO A CLASSICALLY CONDITIONED SUCROSE AVERSION INDUCED BY X-RAY EXPOSURE. Schaeffer, Robert W.; Hunt, Edward L.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 22, 1966. 16p. CFSTI $3.00 cy, $0.65 mn.

Five groups of six rats per group were tested daily for 60 days on a two-bottle 30-min. preference test in which one bottle contained water and the second bottle contained either water or a 4, 8, 16, or 32% sucrose solution. A classically conditioned aversion was induced by pairing the taste of sucrose with an exposure to 100 R of x rays (5 R/min.) on 3 successive occasions. The rate of sucrose drinking prior to, and following each irradiation, as well as the degree of the conditioned aversion, varied directly with the concentration of the sucrose solution. This was interpreted as evidence for the applicability to classical conditioning of Premack's reinforcement theory in which the rate of reinforced responding is determined in part by the precontingency rate of the response. (auth)

16432 (JPRS–38272) PROBLEMS IN AEROSPACE MEDICINE. Parin, V. V. (ed.) Translated from pp 3–414 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966. 540p. (TT–66-34698). CFSTI $3.00 cy, $0.65 mn.

Separate abstracts were prepared on 34 papers that discuss radiation hazards of space flight. Other aspects of space medicine are discussed in 242 papers presented at this conference. (C.H.)

For abstracts of individual papers see: 16343–16348, 16373–16377, 16433–16449, 16517–16519, 16532, 16533, and 16836.

16433 (JPRS–38272, pp 505–6) THE MECHANISMS OF INJURY AND DEFENSE OF THE BONE MARROW OF ANIMALS IN THE CASE OF PROTON AND X-RAY RADIATION. Shimakova, N. L.; Yarmonenko, S. P. Translated from pp 387–8 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results are reported from studies on the kinetics of injury of the bone marrow of mice exposed to whole-body doses of x radiation or high-energy protons at doses of 250 to 700 Rem. Cell destruction, the induction of chromosome aberrations, and effects on mitosis at various times after irradiation were determined. Possible applications in the development of radiation protection procedures are discussed briefly. (C.H.)

16434 (JPRS–38272, pp 442–3) CHANGES IN THE HEMOPOIETIC SYSTEMS OF RATS IRRADIATED WITH PROTONS WITH AN ENERGY OF 126 MeV AND GAMMA RAYS OF ^{60}Co. Seraya, V. M.; Ryzhov, N. I.; Derveneva, N. N.; Mashinskaya, T. E.; Oparina, D. Ya.; Sychkov, M. A. Translated from pp 340–1 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results are reported from a comparison of the effects of a single whole-body exposure to 126-MeV protons or ^{60}Co γ radia-

tion on the cellular composition of the peripheral blood, bone marrow, and spleen of rats at various times after exposure. Results showed an identical nature of the response of the hematopoietic system to protons and γ radiation. The duration and degree of the response depended upon radiation dose. (C.H.)

16435 (JPRS-38272, pp 434) THE INFLUENCE OF THE SPATIAL DISTRIBUTION OF AN ABSORBED DOSE ON THE COURSE OF RADIATION INJURY TO DOGS. Savchenko, N. Ya. Translated from pp 334 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The clinical course of radiation injury to dogs as affected by uneven spatial distribution of the absorbed dose was investigated using multi-sided irradiation with soft and hard x radiation of 80 and 180 kV. The radiation exposure simulated the conditions that will be encountered by astronauts during space flights. No results are included. (C.H.)

16436 (JPRS-38272, pp 336-7) THE COMPLEX ACTION OF VIBRATION AND IONIZING RADIATION ON THE CONDITIONED REFLEX ACTIVITY OF RATS. Livshits, N. N.; Meyzerov, E. S. Translated from pp 259-60 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results are summarized from studies on the combined effects of a single dose of (50 R) x radiation, or a series of 2 or 3 exposures to 50 R, and vibration on conditioned reflex in rats. The data indicated that the effects of radiation and vibration are additive and resulted in a lowering of conditioned reflex response. (C.H.)

16437 (JPRS-38272, pp 334-5) THE COMBINED ACTION OF VIBRATION AND IONIZING RADIATION ON THE METABOLISM AND FUNCTIONING OF THE CENTRAL NERVOUS SYSTEM. Livshits, N. N.; Apanasenko, Z. I.; Kuznetsova, M. A.; Luk'yanova, L. D.; Meyzerov, E. S. Translated from pp 257-8 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The combined effects of a single exposure to a lethal dose of γ radiation or exposure to 500-R γ delivered over a 14-hr period with vibration before or after irradiation on oxidative processes in the tissues of the brain, the vestibular reflex, and the electrical activity of skeletal muscles were studied in guinea pigs and rats. Results showed a complex reaction to the combined effects of radiation and vibration. (C.H.)

16438 (JPRS-38272, pp 340-1) THE QUESTION OF THE BIOLOGICAL EFFECT OF COMBINED X-RAY AND SUPER-HIGH FREQUENCY RADIATION. Loshak, A. Ya. Translated from pp 262-3 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results of preliminary studies on rats indicated that exposure of the whole body or head only to microwaves of non-thermal intensity before exposure to 900-R x radiation reduced the life span of the animals when compared with x-irradiated controls. (C.H.)

16439 (JPRS-38272, pp 356-7) COMPARATIVE STUDY OF THE CYTOGENETIC EFFECT OF PROTONS WITH AN ENERGY OF 630 MeV AND OF THE GAMMA RADIATION OF ^{60}Co. Mastryukova, V. M.; Strzhizhovskii, A. D. Translated from pp 275-6 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The relative biological effectiveness of 630-MeV protons and ^{60}Co γ radiation were compared, using the induction of chromosome aberrations in corneal epithelium of mice as the test object. Results indicated that the relative biological effectiveness of the protons was equal to 0.7 in comparison with γ radiation. (C.H.)

16440 (JPRS-38272, pp 430-1) THE RELATIVE BIOLOGICAL EFFECTIVENESS OF PROTONS OF 126 MeV UPON REPEATED IRRADIATIONS WHICH HAVE BEEN LIKENED IN FREQUENCY TO SOLAR FLARES. Ryzhov, N. I.; Derbeneva, N. N.; Seraya, V. M.; Mashinskaya, T. E.; Aparina, D. Ya.; Govorun, R. D. Translated from pp 331-2 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The relative biological effectiveness of 126-MeV protons and x radiation was evaluated in rats using changes in the blood picture and life span. Repeated exposure to various doses during a year time interval was used as the criteria. Exposure to a total dose of 3600 rad of either protons or x radiation caused 100% lethality. It was concluded that there is no difference in the biological effectiveness of 126-MeV protons and 180-kV x radiation under the experimental conditions used. (C.H.)

16441 (JPRS-38272, pp 320) THE INFLUENCE OF THE COMPLEX ACTION OF MULTIPLE VIBRATION AND FRACTIONATED IRRADIATION ON THE STATE OF THE ARCH OF THE SPINE-BRAIN REACTION. Kuznetsova, M. A. Translated from pp 246-7 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The effects of vibration alone, fractionated doses of x radiation, and the combined effects of vibration and fractionated irradiation on the latent period of unconditioned response to nerve stimulation were investigated in laboratory animals. The radiation dose used was 500 R delivered in fractionated components. Both vibration and irradiation affected the latent period of an unconditioned defensive motor reaction, but in different degrees. In both cases the influence of the additional agent affected the reactions being investigated. (C.H.)

16442 (JPRS-38272, pp 282) THE COMBINED ACTION OF ACCELERATION AND IONIZING RADIATION ON THE ORGANISM OF ANIMALS. Konnova, N. I. Translated from pp 218 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results are summarized from a study on the combined effects of acceleration and γ radiation on mice, rats, and dogs. The biological parameters measured included mortality, life span, body weight, and changes in the peripheral blood. The animals were subjected to centrifugation for various times and at various rates before or after exposure to 600 R γ radiation. Species differences were observed in all parameters measured, with the exception of leukopenia, the degree of which also varied with respect to species. (C.H.)

16443 (JPRS-38272, pp 158-9) THE INFLUENCE OF CONSIDERABLE MUSCLE LOADS AND OF CERTAIN PHARMACOLOGICAL PREPARATIONS OF THE SUBSEQUENT RESISTANCE OF WHITE RATS TO RADIATION. Golovacheva, D. A. Translated from pp 126-7 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The effects of physical fitness on the resistance of rats to the effects of x radiation was studied. Results showed that rats subjected to a training period for 2 to 3 months before exposure to 1100-R x radiation showed a 31% survival compared with 100% mortality of the control group. The administration of drugs that stimulated muscular activity had no effect on the radiosensitivity of trained rats but caused an increase in radiation resistance in rats with a low level of muscular ability. (C.H.)

16444 (JPRS-38272, pp 154-5) STUDY OF THE EFFECT OF PROTONS OF 126 MeV AND GAMMA RAYS OF ^{60}Co ON THE PROCESSES OF CELL DIVISION IN THE BONE MARROW OF WHITE RATS. Govorun, R. D.; Vorozhtsova, S. V. Translated from pp 123-4 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Rats were exposed to a single dose of 126-MeV protons or ^{60}Co γ radiation at doses ranging from 100 to 1000 rad. The animals were killed at various time intervals from 1 hr up to 30 days after irradiation and bone marrow extracted from the femur was examined for changes in the mitotic index and chromosome aberrations. A distinct relation was observed between radiation dose and mitotic index at various times after irradiation, with a considerable increase in the number of metaphases observed 6 to 48 hr after irradiation and a decrease in the number of prophases and anaphases during the first day. Gamma radiation resulted in more cells with degenerated nuclei during the first post-irradiation day than did 126 MeV protons. A clear relation was found between radiation dose and the number of cells with chromosome aberrations at various times after irradiation. It was concluded that the evaluation of the relative biological effectiveness of 126 MeV protons and γ radiation depends on the time of investigation and on the tests used. (C.H.)

16445 (JPRS-38272, pp 246-7) THE ROLE OF THE CERVICAL AND ABDOMINAL REGIONS OF THE SYMPATHETIC NERVOUS SYSTEM IN CHANGES OF THE BLOOD AND BLOOD CIRCULATION UPON THE ACTION OF CHRONIC HYPOXIA AND IONIZING RADIATION. Kalinina, T. V. Translated from pp 190-1 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Different groups of rats received training involving 4 hr/day in a barometric chamber simulating gradual ascent to an altitude of 7500 m during the course of a month before exposure to various doses of x radiation. The effects of removal of the cervical and abdominal parts of the sympathetic nervous system on the adaptation of the rats to hypoxic conditions and radiation injury were followed from the indices of the peripheral blood, blood pressure, and the tonus of the peripheral blood vessels. A cervical sympathectomy led to various changes of the blood pressure and to an increase of the tonus of caudal blood vessels, did not change the composition of the blood or hamper adaptation to chronic hypoxia, but led to an increased radiosensitivity. An abdominal sympathectomy caused noticeable anemia and leukopenia due to a reduction in the number of lymphocytes, led to a sharp increase of

arterial pressure with some reduction of the tonus of caudal blood vessels, and reduced the ability of the rats to adapt to hypoxia, but did result in a decrease in radiosensitivity. (C.H.)

16446 (JPRS-38272, pp 231-2) THE BIOLOGICAL EFFECT OF A 12-TIME REPEATED GAMMA RADIATION TREATMENT OF WHITE MICE. Zukhbaya, T. M.; Kalandarova, M. P.; Markelov, B. A.; Popova, N. A.; Sizan, E. P.; Khakhanova, N. L. Translated from pp 178-9 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Mice were exposed once a month to doses of 12.5 R γ radiation over the period of one year, with a total of 150 R. The dynamics of injury and recovery were evaluated at various times during and after the radiation exposure. Hematological studies showed a clear reaction of the hematopoietic system to repeated irradiations as revealed by changes in the leukocyte count. Investigations of the mitotic activity of the epithelium of the cornea of the eyes of the test mice also showed a reaction to repeated irradiations. A study of conditioned reflexes at various periods after completion of the series of irradiations showed a compensation of the central nervous system to the effects of repeated low-dose irradiations. All of the changes detected disappeared with time. Implications of the findings to the reactions of astronauts to repeated radiation exposures during space flights are discussed briefly. (C.H.)

16447 (JPRS-38272, pp 189-90) NEW DATA ON THE MECHANISMS OF THE ACTION OF IONIZING RADIATION ON THE FUNCTIONAL PROPERTIES OF THE RETINA. Demirchoglyan, G. G. Translated from pp 149-50 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Results are summarized from studies on the effects of ionizing radiation on the visual functions of the retina of frogs and rabbits. An attempt was made to identify reaction mechanisms that cause the extreme radiosensitivity of the retina. A study was made of the radiosensitivity of the optical photopigments that accomplish primary perception and transformation of light energy. Spectrophotometric measurements of irradiated retina indicated a possible change in content of rhodopsin, the basic visual pigment of the retina, without a change in the structure of the molecule. Amperometric titration indicated a decrease in free sulfhydryl groups in solutions of irradiated rhodopsin extracted from the retinas of frogs. Definite morphological and histological changes observed in irradiated retinas of rabbits indicated disturbances of metabolic processes, accompanied by a disturbance of visual functions as determined from an electroretinogram made during irradiation by means of a remote recording device. Despite the changes in the retina, the irradiated optical nerve preserved the ability to perceive and process visual information. The possible effects of penetrating radiation on the visual functions of astronauts during space flight are considered briefly. (C.H.)

16448 (JPRS-38272, pp 47-8) THE COMBINED EFFECT OF ACCELERATIONS, VIBRATIONS, AND RADIATION ON THE DIVISION OF THE CELLS OF THE BONE MARROW. Arsen'eva, M. A.; Antipov, V. V.; Belyaeva, L. A.; Golovkina, A. V. Translated from pp 39-40 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Results are reported from a study of the combined effects of acceleration, rotation, and x radiation on mitotic time and the induction of chromosome aberrations in the bone marrow of mice. The animals were subjected to various combination of acceleration (8 and 10 g's for 15 or 30 min) and vibration (700 cycles, at an amplitude of 0.005 mm for 60 min) before or after exposure to doses of 100- or 350-R x radiation. The bone marrow was examined at various times up to 7 days after treatment. Acceleration with subsequent irradiation slowed the rate of recovery of mitotic activity when compared with the effects of radiation alone. The combination of acceleration, vibration, and irradiation caused an increase in the number of chromosome aberrations. (C.H.)

16449 (JPRS-38272, pp 45) THE ROLE OF THE VESTIBULAR ANALYZER IN THE RESPONSE REACTIONS OF AN ORGANISM TO RADIATION EFFECTS. Arlashchenko, N. I. Translated from pp 38 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Rabbits were exposed to an LD_{40} radiation dose on the second day after the destruction of equilibrium functions by bilateral vestibulotomy. A 100% lethal response of the test animals resulted. Irradiation using an LD_{40} dose immediately after bilateral vestibulotomy led to an LD_{80} response, as judged by the onset of radiation sickness. The effects of the additional physiological stress caused by the exposure of astronauts to cosmic radiation on the function of the vestibular apparatus that may be disturbed due to the state of weightlessness and the effects of Coriolis forces are discussed briefly. (C.H.)

16450 (NP-tr-1483) ROLE OF PEROXIDES AND OXYGEN IN THE FIRST STAGES OF THE RADIOBIOLOGICAL EFFECT. OXYGEN AND THE THEORY OF THE PRIMARY RADIOBIOLOGICAL EFFECT. Shekhtman, Ya. L. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from pp 116-35 of Rol'Perekisei i Kisloroda v Nachal'nykh Stadiiakh Radiobiologicheskogo Effekta, Izdatel'stro Akademmi Nauk SSSR, Moscow, 1960. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $3.60 fs, $1.22 mf.

Various theories as to mechanisms involved in the direct and indirect effects of ionizing radiation on biological systems are reviewed. It is pointed out that an enhanced radiobiological effect is observed when irradiation takes place in the presence of oxygen and that the direct effect of radiation is due to effects on cell nucleoproteins that affect cell structure while the indirect effect of radiation is due to the formation of active radicals, particularly the HO radical, during radiolysis of the cell water. It is concluded that present knowledge is insufficient for a clean understanding of the direct effects of radiation on cells or for elucidating the role of peroxides or oxygen in the direct radiation effect. (TSS)

16451 CARDIOVASCULAR INVOLVEMENT BY GYNECOLOGIC RADIUS IRRADIATION. Brehm, Herbert (Univ., Frankfurt am Main). Geburtsh. Frauenheilk., 26: 740-3(May 1966). (In German).

Changes in cardiovascular status were measured in 24 patients treated with Ra implants. The studies were made before, during, and after a total of 54 implants with an average dose of 2000 mg-hr. The average age of the patients was 53 yr. Blood pressure dropped slightly, pulse rates increased by 15 to 20 mm Hg. Within 1 week these values became normal. Minute volumes decreased as much as 4 liters/min and autonomic tonus decreased. Cardiac output decreased for more than 10 days after Ra implantation. The results suggested that during and after Ra implantation the cardiovascular status of each patient worsened, probably because of an initial vasoconstriction, which was sustained by a subsequent long-term vasodilatation. The reasons for these phenomena are not apparent. Because of these effects on the cardiovascular system caused by Ra implantation, it would probably be advisable to administer a depot circulatory stimulant routinely during the second half of the implantation period, generally in the late afternoon or evening of the day of implantation. Follow-up studies of the cardiovascular system should be made during the weeks or months following the Ra implantation. (BBB)

16452 ENVIRONMENTAL HAZARDS: IONIZING RADIATION. Little, John B. (Harvard School of Public Health, Boston). New Engl. J. Med., 275: 929-38(Oct. 27, 1966).

Evidence is reviewed pointing to facts that support the theories that the major biologic effects of ionizing radiation at low doses and low dose rates are carcinogenic and that the production of genetic mutations in the gonads is passed on to offspring. The biological effects of ionizing radiations on individuals and populations are discussed. Consideration was given to the many possible sources of radiation that can be hazardous to man. (TSS)

16453 EFFECT OF APPENDECTOMY AND OF THYMECTOMY, WITH X-IRRADIATION, ON THE PRODUCTION OF ANTIBODIES TO TWO PROTEIN ANTIGENS IN YOUNG RABBITS. Konda, Susumu; Harris, T. N. (Children's Hospital Philadelphia). J. Immunol., 97: 805-14(Dec. 1966).

Three-week-old rabbits were thymectomized, appendectomized, or both, and then subjected to 450 R of whole-body x radiation. Four weeks later, when normal rabbits would have recovered from the radiation effects, all the animals were injected with a mixture of conalbumin and Salmonella typhi. The blood lymphocyte counts of thymectomized rabbits were distinctly lower than those of the irradiated controls, but those of the appendectomized rabbits were unaffected. Antibody responses to the antigens showed deficiencies in both the thymectomized and appendectomized groups, with differences in the responses of the 2 groups to the respective antigens. The thymectomized-irradiated rabbits showed decreased antibody response to conalbumin, but a normal response, in comparison to the irradiated control animals, in the production of H-agglutinins to Salmonella. Appendectomized animals showed a diminution in anticonalbumin production, similar to that of the thymectomized rabbits, but produced no detectable H-agglutinins to Salmonella. In the thymectomized-appendectomized group, there was a reduced response, although the appendectomized group produced no detectable antibody. In nonirradiated rabbits injected on the same schedule, the control rabbits showed titers as high as that in control irradiated rabbits, with no difference among control, appendectomized, or thymectomized groups. (BBB)

16454 ROLE OF THE ADRENAL CORTEX IN INCREASING RESISTANCE OF X-IRRADIATED WHITE MICE TO ACUTE HYPOXIA. Vasil'ev, G. A.; Medvedev, Yu. A. (State Inst. for the Advanced Training of Physicians, Leningrad). Radiobiologiya, 6: 618-19(1966). (In Russian).

The effects of x-irradiation on resistance to acute (anoxic, anemic, and histotoxic) hypoxia were studied in white mice irradiated with doses of 50, 100, 200, 500, 700, and 1000 R. Mice were observed at 3 hr, and 1, 2, 3, 5, 6, and 10 days after irradiation. The content and distribution of sudanophilic and anisotropic lipids in the adrenal cortex, and the weight coefficient and size of the adrenals of 50 irradiated mice were determined. Results on the survival of irradiated animals are presented. Resistance to acute anoxic hypoxia was increased by doses from 200 to 700 R; the increase was observed by the third hr after 700 R irradiation and lasted 50 days. Resistance to carbon monoxide and potassium cyanide was also significantly increased by the 700-R dose. Smaller (50 and 100 R) and larger (1000 R) doses provided no protection. No changes were noted in the weight coefficient or size of the adrenal cortex in mice examined one day after 100 and 1000 R irradiation. The 700-R dose produced statistically significant hypertrophy of the cortex and an increase in weight coefficient by the third postirradiation hr, with the weight coefficient reaching twice normal value by the 2nd, 3rd, 4th, 6th, and 10th postirradiation days. A slight decrease in sudanophilic and increase in anisotropic lipoids was observed in the external branches of the fascicular cortical zone in animals examined the first day after 100 R irradiation, compared to a sharp drop in anisotropic lipoid content and change in the aggregate lipoid state of the protoplasm of the fascicular cells with the 1000-R dose. The 700-R dose produced a gradual decrease in sudanophilic and anisotropic lipoid content from the third hr to the fourth day after irradiation when it reached zero, and a sharp increase on the 6th and 10th postirradiation days, that confirmed an increase in functional activity of the adrenal cortex for the first four days after 700 R irradiation. It was concluded from a comparison of data that the increased resistance of irradiated mice to different types of hypoxia was a nonspecific reaction effected through the adrenal cortex. (ATD)

16455 EKG CHANGES OCCURRING UNDER THE EFFECTS OF A SUPERHIGH-FREQUENCY ELECTROMAGNETIC FIELD. Paliev, B.; Goshev, Khr. Voenno-Med. Delo, No. 4, 34-41(1966). (In Russian).

An EKG analysis of military personnel working around SHF fields was conducted. Findings were compared with data gathered from personnel not exposed to such fields. Results of the investigation are presented in table form. The cardiac characteristics of personnel exposed to SHF fields are summarized. A wide range of pulse rates wherein both substantial bradycardia and tachycardia were characteristic was noted. (auth)

16456 VARIABLES IN THE RADIATION-ATTENUATION OF HELMINTH LARVAE: THE EFFECT OF DIFFERENCES IN QUALITY OF RADIATION. Kassai, T. (Veterinary Univ., Budapest); Fitzpatrick, B.; Mulligan, W. Parasitology, 56: 651-6(Nov. 1966).

A comparison of the attenuating effects of 140-kV x rays and γ rays from ^{60}Co on Nippostrongylus brasiliensis larvae was made. Larvae were treated with doses of 10, 20, 40, 60, and 80 kR of x rays or with the same total doses of γ rays at a dose-rate of 170 R/min. Groups of rats were infected with the irradiated preparations. The mean numbers of worms recovered 10 days after infection indicated that an increase in infectivity was produced by low doses of radiation. This effect was observed in the dose range up to 20 kR. Attenuation was manifested as a reduction intake of irradiated larvae as compared to the non-irradiated control preparation. The relative take at the 5 doses was 274, 101, 3, 1.3, and 0.1% for x rays, and 190, 187, 41, 2.9, and 1.6% for γ rays. Another experiment was carried out to cover the dose range of the previous one in smaller steps and to study the alteration in sex-ratio of worms as a measure of attenuation. Larvae were treated with x-ray doses of 5, 10, 15, 20, 25, 40, and 60 kR of the same quality as before but delivered at 700 R/min. Rats were infected with 1000 larvae each of the irradiated preparations and killed 10 days later. Increased infectivity at low doses was again evident. The sex-ratio of the worms, expressed as the percentage of males in the population, showed a consistent decrease from 0 to 25 kR, but beyond this point was unreliable as an index of radiation effect because of the small numbers of worms being recovered at the higher doses. The results showed that γ rays from ^{60}Co were slightly less effective than 140-kV x rays, the RBE of γ rays being about 0.7 as compared to that of x rays taken as unity. This applied within the range where attenuation was manifested as a reduction in total worm burden. (BBB)

16457 EFFECTS OF LASER RADIATION ON INTRACRANIAL STRUCTURES. Fox, J. L. (Veterans Administration Hospital, Washington, D. C.); Hayes, J. R.; Stein, M. N.; Green, R. C. pp 552-4 of Proc. Third Intern. Congr. Neurol. Surg., Aug. 23-7, 1965, Copenhagen. Amsterdam, Exerpta Medica Foundation, 1966.

The effects of a single pulse train of ruby laser radiation with a wavelength of 6943 Å upon intracranial structures of guinea pigs were studied. The beam was focused upon the cerebral hemisphere directly through a craniectomy and indirectly by focussing on the intact skull. The focus was about 1 mm in diameter, and the skull was about 1 mm thick. About 100 J of energy was delivered during 2.5 msec, giving a power density of 4 Mw/cm^2 on the exposed surface. Direct irradiation of the skull produced a cessation in breathing; heart action continued normally for several minutes, then became irregular, and ceased within 15 min from ischemia. Autopsy revealed a local leptomeningeal and cerebral cortical hemorrhagic lesion and also marked hemorrhage about the brain stem and tentorial notch. This occurred in spite of the fact that the skull filtered out 90% of the energy, giving only 10 J to the cortical surface. When the brain was directly irradiated through a craniectomy, 10 times as much energy reached the cortical surface; however, animals did not immediately die and often survived several hours in spite of the more extensive cortical lesion. In these cases, hemorrhage at the base of the brain was minimal or absent. It was concluded that destructive overpressures were dissipated into the air when the skull was open, but that in the presence of an intact skull, these pressures were confined and caused severe herniation of the brain. Although the skull filtered out 90% of the laser energy, the remaining energy was sufficient for production of intracranial pressures that were high enough to herniate the brain down the path of least resistance: the foramen magnum and tentorial notch. (BBB)

16458 THYROID CARCINOMA AFTER RADIATION THERAPY FOR ADOLESCENT ACNE VULGARIS. Albright, Edwin C.; Allday, Robert W. (Univ. of Wisconsin, Madison). J. Amer. Med. Ass., 199: 280-1(Jan. 23, 1967).

In five patients who underwent x radiotherapy for acne vulgaris during middle to late adolescence that was not directed at the thyroid gland, thyroid cancer developed in each after several years. The first case, a 24 yr-old woman received 1800 R (100 kV) to each side of the face and neck at the age of 17. The second, a 23-yr-old woman received a total of 900 R to the face and upper thorax over a 3-month period at age 16. The third patient developed thyroid carcinoma 5 years after undergoing an undetermined amount of x ray therapy. The fourth patient, a 58-yr-old woman, underwent x ray therapy of unknown amounts at ages 16 to 21 for severe acne of the face, neck, back, and chest. Case 5, a 44-yr-old physician received x ray therapy of undetermined amount to a skin lesion on the upper thorax as a child. Evidence suggested that the younger the patient the greater was the risk of thyroid carcinogenesis from indirect irradiation. A review of the literature showed that among patients in whom thyroid carcinoma developed after radiotherapy in adolescence, over 80% received only incidental thyroid irradiation. (BBB)

16459 EFFECTS OF INTERNALLY DEPOSITED RADIONUCLIDES ON THE THERMAL TOLERANCE OF FISH. Ophel, I. L.; Judd, J. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 825-33 of STI-PUB-126.

The gross effects of massive, acute doses of radiation on fish are well known. Other, more subtle, effects of chronic irradiation, particularly those caused by internal emitters, have received less attention. Laboratory experiments have been performed to determine the effect of radiation from internally deposited radionuclides on the survival time of fish exposed to lethal temperatures. Goldfish (Carassius auratus) of 1 to 3 g in weight were used in the experiments. Preliminary experiments were concerned with the effects of fish weights, length of acclimation period and photoperiod on survival of control fish at high temperatures. Two radionuclides were used, both singly and in combination, in the radioactive experiments: (1) strontium-90 which delivers most of its dose to the bony tissues and (2) iodine-131 which is largely confined to the thyroid tissue. Groups of fish were kept in solutions of the radionuclides for short periods of time. Subsequently, a group of radioactive fish and a nonradioactive control group were acclimated together for at least 10 d to a water temperature of 25 ± 0.1°C. The mixed group was then transferred to a single high-temperature bath held at 38 ± 0.1°C. Each fish was observed until respiratory movements had ceased and the survival time was then recorded. Individual fish were removed immediately after death and each was assayed for radionuclide content after completion of the experiment. A wide range of radionuclide concentrations was

used in a series of experiments. The estimated average doses (whole-body) to fish have ranged from approximately 1 rad to 900 rad. Fish from experiments in which very low doses of radiation had been accumulated showed no significant difference in survival times compared with their control groups. Where higher doses had been accumulated, fish showed a considerable increase in mean survival times. (auth)

16460 RESISTANCE OF FISH EGGS TO ACUTE AND CHRONIC IRRADIATION. Templeton, W. L. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 847-60 of STI-PUB-126.

The development of the eggs of the fresh-water brown trout (Salmo trutta) and the marine plaice (Plemonectes platessa) have been studied under low-level chronic conditions. The effects of the treatments were assessed in terms of proportions of eggs hatching, abnormal larvae on hatching, and larval length. Initially, the low-level chronic doses were given from a medium contaminated with ^{90}Sr (10^{-4} μCi/l to 100 μCi/l), but since the highest levels exceeded those that would be allowable in the environment by many orders of magnitude, the experiments were redesigned. Gamma-ray sources were used to irradiate the marine eggs which float on the surface, and the fresh-water eggs which remain on the bottom. Dose rates ranged from 0.035 R/d to 150 R/d. (L.C.L.)

16461 PSEUDOMONAS AERUGINOSA INFECTION AND RADIOBIOLOGICAL RESEARCH AT ARGONNE NATIONAL LABORATORY: EFFECTS, DIAGNOSIS, EPIZOOTIOLOGY, CONTROL. Flynn, Robert J. (Argonne National Lab., Ill.). Lab. Anim. Care, 13: 25-35(Feb. 1963).

The mean survival time of CF1 mice subjected to a single whole-body dose of 700 R x radiation (an $LD_{100/30}$ dose) dropped from 13.8 days to 6.0 days because of P. aeruginosa infection of the animal colony. Many radiobiological studies were affected, particularly those concerned with protection against radiation injury. Various diagnostic procedures were studied and evaluated. Tests based on P. aeruginosa's unique ability to produce pyocyanin were found to be the most useful for the mass screening of mouse colonies. The most efficient technic consisted of culturing individual fecal or group water bottle samples in Wensinck's glycerol broth at 37C for 7 days and then testing the culture for the chloroform-soluble pigment. The epizootiology of the infection was also studied. One of 12 animal caretakers and about 25% of the cockroaches infesting the animal quarters were found to be infected, but an extensive survey of various inanimate materials (building, equipment, feeds, breeding) showed that when good sanitation is employed such materials are rarely infected. Control procedures based on the removal of the probable source of infection (animate vectors) and the prevention of the spread of existing infection through good sanitation are described. (BBB)

16462 FATTY ACID CHANGES IN PIGEONS AFTER LETHAL-BODY RADIATION AND BONE MARROW AND THYMUS ADMINISTRATION. Chung, R. A.; Shaw, D. H.; So, E. S. (Tuskegee Inst., Ala.). Ind. Med. Surg., 39: 607(July 1966).

Noninbred sexually mature pigeons (Columbia livia), 6-10 months of age, were exposed to 2900 rad, total-body x irradiation. The birds were separated into the following groups: heterologous marrow transplant (HMT), heterologous thymus transplant (HTT), HMT + HTT, irradiated control (IC), and unirradiated control (UC). Bone marrow and thymus were obtained from single ringneck doves (Streptopelia risoria) and were administered to the pigeons 5 days after irradiation. The fatty acid composition of the liver lipids of the donor (dove) and the UC group was similar. The proportion of stearic and linoleic acids was greater and that of arachidonic acid was less in the heart and breast lipids of the UC group than in the donor (dove). The heart, breast, and liver lipids of the IC group showed greatly increased proportions of stearic acid and greatly decreased proportions of palmitoleic and oleic acids over those in the UC group. Palmitic acid level decreased and arachidonic acid level increased to a lesser extent. Irradiation, whether followed by HTT, HMT or HMT + HTT, increased the arachidonic, docosatetraenoic, and docosahexaenoic acid levels in all 3 tissues except in the liver of the IC group. The effect of HMT, HTT, and HMT + HTT on stearic acid level was less and on oleic and arachidonic acid levels was greater than the effect of IC. (BBB)

16463 ROLE OF VIRUS IN RADIATION LEUKEMOGENESIS. Irino, Shozo; Sota, Susumu; Hiraki, Kiyoshi (Okayama Univ., Japan). Gann, 57: 507-11(Oct. 1966).

The incidence of leukemia in RF mice exposed to a single whole-body dose of 350 R x radiation was 77.4% (41 out of 53 mice). Twenty animals developed the thymic type and 20 others nonthymic type lymphocytic leukemia, while only one developed myelogeneous leukemia. The spontaneous incidence of leukemia in RF mice was 0.7% (2 out of 300 mice). After inoculation of the cell-free filtrates from leukemic RF mice, induced by a single whole-body x irradiation of newborn mice of the same strain less than 16 hours old, 4 (25%) of 16 inoculated animals developed leukemia 12 to 22 months after the inoculation. In serial cell-free transmission experiments the development of leukemia was observed in 60%, 6 out of 10 in the second passage, and in 17%, 1 out of 6 in the third passage. In the inoculation of the cell-free filtrates from normal mice to 20 newborn mice of the same strain, no leukemia developed. It is suggested that low-leukemia pedigreed mice, such as C57BL, and RF strains, maintain a potentially leukemogenic agent as a provirus in a masked or inactive form and under normal conditions they can normally live without developing leukemia. Irradiation seems to act as a trigger on the inactive agent and thus the activated agent with its leukemogenicity elicits leukemia in the host animal. This activated agent, after passing through a filter and being isolated from the cells by filtration, may be transmitted to a mouse in which it is inoculated. (BBB)

16464 ON THE ACTION OF X IRRADIATION ON THE KINETICS OF HUMAN OVIDUCTS IN VITRO. Lakomy, Tadeusz; Omelianowicz, Jan (Medical Academy, Danzig). Ginekol. Pol., 36: 1415-22(Dec. 1965). (In Polish).

Spontaneous contractility of human oviduct in vitro as affected by x irradiation was studied. Thirty oviducts were obtained from surgical operations. A new type of dosimeter was designed and constructed for measurement of radiation doses in the suspending fluid used for these experiments. The dosimeter consisted of a 2-mm baseplate of Al, over which was a 0.3-mm layer of Se, and over this a thinly sprayed layer of Bi-Sn-Cd alloy. A galvanometer and potentiometer completed the circuit between the upper and lower plates. X irradiation caused a passage of electrons from the semiconductive Se layer into the Bi layer, resulting in a rise in potential in the Be layer, detected galvinometrically. It was shown that this device was sensitive to low-energy x rays, and the dose measured was independent of dose rate and energy of the x rays. Spontaneous contractions of the oviducts suspended in Genell's fluid were registered before and after irradiation with doses of 4 to 20 R. In 5 of the 30 oviducts tested, a decrease in muscular tension after irradiation was noted. The frequency of contraction decreased in 5 cases and the amplitude decreased in 3. Irradiation of the suspension fluid with 60-R doses caused a decrease of contraction amplitude 1 to 3 min postirradiation. In this instance the oviduct received ~12 R. (BBB)

16465 ELICITATION OF DELAYED HYPERSENSITIVITY (DNCB CONTACT DERMATITIS) IN MARKEDLY PANLEUKOPENIC GUINEA PIGS. Maibach, Howard I. (Univ. of California, San Francisco); Maguire, Henry C. J. Invest. Dermatol., 41: 123-7(Sept. 1963).

Data are presented which show, contrary to expectation, that contact sensitized guinea pigs deprived of circulating white blood cells by a cancer chemotherapeutic drug or whole-body x irradiation give normal allergic eliciting reactions. Gross and histological examinations of contact dermatitis sites in guinea pigs, made panleukopenic by these means, are reported. Dinitrochlorobenzene (DNCB)-sensitized guinea pigs made severely panleukopenic (total circulating white blood count of 0 to 800 cells/mm^3), when elicited with DNCB, displayed the same allergic gross dermatitis reaction as control animals. Treatment with Cytoxan or whole-body x-ray exposure (300 to 500 R) had no perceptible effect on the allergic contact dermatitis eliciting reaction. Histologically, the dermatitis showed only minimal round cell infiltration and no evidence of epidermal involvement. The histopathological changes did not match the clinical appearance. An exception to this observation was that severely debilitated guinea pigs gave weakened skin reactions, both of the specific allergic and non-specific primary irritant types. The white blood cell is responsible for the major epidermal injury; induced leukopenia seemingly protects the epidermis from agents that would otherwise produce epidermis damage. It is postulated that the antibody of delayed hypersensitivity (DNCB contact dermatitis) separates from the lymphocyte early in the process of sensitization in a manner analogous to that of the antibodies of immediate hypersensitivity. (BBB)

16466 TREATMENT OF POLYCYTHEMIA VERA (P. VERA). Gardner, Frank H. (Presbyterian-Univ. of Pennsylvania, Philadelphia). Seminars Hematol., 3: 220-5(July 1966).

Use of external radiation and ^{32}P to treat this disease is considered, and the literature is reviewed, as well as the author's own experience, relating to development of leukemia in irradiated patients. In one series, 11% of the patients developed leukemia following ^{32}P therapy, compared with less than 1% of patients treated by phlebotomy (nonradiation group). Although there was no evidence that ^{32}P shortens the lifespan of the patients, this complication deserves careful consideration in the future therapy of this

disease. There is confusion as to whether the clinician should accept the diagnosis of acute leukemia in this disease, especially if survival is prolonged after the initial appearance of blast cells in the peripheral circulation. In another series of patients who did not receive irradiation, not a single case of acute leukemia was observed. The figures are not accurate regarding the frequency of leukemia in the nonirradiated patients. In the author's series, one female patient developed leukemia after only phlebotomy and busulfan therapy. Leukemia has been observed with doses as low as 7 mC and as high as 60 mC. This may reflect the total radiation exposure required for the causation of leukemia, which may develop at any time in the treatment program with ^{32}P. It is concluded that prolonged survival will increase the frequency of leukemia in this disorder and that radiation is the best current method to improve survival, is associated with less vascular complications, and should be used. (BBB)

16467 COMMENTS ON THE THERAPY OF POLYCYTHEMIA VERA. Dameshek, William (Tufts Univ., Boston). Seminars Hematol., 3: 226-7(July 1966).

Alternative therapy to radiophosphorus, which is implicated as a probable leukemogenic agent in this disease, is proposed. Phlebotomy and chemotherapy are recommended as less likely to cause serious, late complications in polycythemia. Opposition is expressed to the use of ^{32}P therapy and the other forms of ionizing radiation in the treatment of a very chronic and benign disease such as polycythemia vera. Less drastic therapy and no therapy at all may be better. After an initial blood letting, the patient should be observed at monthly intervals, and hematocrit determinations done. After slight rise in 3 to 6 months, 2 to 4 phlebotomies may again be done at 3- to 5-day intervals, and eventually the patient may require venesections at perhaps 6 to 18 month intervals. Should high hematocrit values return quickly, a cytotoxic agent such as Myleran should be given. With this drug over a period of 10 years, no indications of the development of acute leukemia were observed, which is contrary to experience with ^{32}P. Circulatory symptoms of polycythemia vera vary greatly from patient to patient and it is doubtful whether these complications are more numerous in patients treated primarily with phlebotomies than with ^{32}P. If the platelet count remains at extremely high levels (4 to 10 times normal), it can be lowered with Myleran therapy. As for ^{32}P, not only is it a leukemogenic agent, but the rather large doses which may be required to bring the platelet level to normal values introduce a real hazard to the marrow. (BBB)

16468 POLYCYTHEMIA: CONCLUSION. Gardner, Frank H. (Presbyterian-Univ. of Pennsylvania, Philadelphia). Seminars Hematol., 3: 232-4(July 1966).

Comments summing up a symposium on the treatment of polycythemia vera are provided which assess the concensus of investigators regarding the leukemogenic hazards of ^{32}P treatment of this desease. It is evident that acute leukemia is an occasional sequela of the disorder even when radiotherapy is not utilized. There was a divergence of opinion regarding the best therapy among the participants. Phlebotomy can be used in some cases, but most patients may need myelosuppressive therapy. Whether the risk of leukemia outweighs the benefits of irradiation therapy, and whether alkylating agents (busulfan or cyclophosphamide) protect the patients from the complication of leukemia could not be unequivocally stated. Both types of treatment may hasten the onset of myelofibrosis. The proper therapy program may depend on the ethnic group treated. It is suggested that better criteria for diagnosis of leukemia are needed to properly assess the leukemogenic effect of radiation. (BBB)

16469 POLYCYTHAEMIA VERA. Hainan, Keith E. (Western Infirmary, Glasgow). Lancet, 1: 1377(June 18, 1966).

Comments are made on previous publications reflecting the incidence of leukemia in polycythemia patients treated with radiophosphorus. The absence of any case of leukemia in the Christie Hospital in the author's series does not mean that there is no added risk of leukemia, but does at least suggest that the incidence should be substantially lower than the minimum of 10% suggested by Modan. Modan also suggested that only 21 of the author's patients had been followed up for over 6 yr; however, 58 patients had been followed up for 5 yr, 47 for 7 yr, 37 for 10 yr, and 12 for 15 yr. The incidence of leukemia must be dose dependent, and it may be relevant to the author's results that none of the patients at the Christie Hospital were given a total of more than 42 mC of ^{32}P, and that consideration was always given to the possibility of alternative chemotherapy when a large quantity of ^{32}P had already been given. A clinical trial is now being conducted in Manchester in collaboration with M.C.G. Israels and his colleagues, and the author is now attempting with Szur of Hammersmith Hospital to stimulate the initiation of a larger clinical trial to compare the results of management of polycythemia vera with and without radiotherapy. (BBB)

16470 TUMOR ANOXIA AND THE RESPONSE TO RADIATION. Thomlinson, R. H. (Medical Research Council, London). Sci. Basis Med.: Annu. Rev., 74-90(1965).

Radiobiologic aspects of the effects of oxygen on normal and malignant cells are reviewed. These questions are discussed in particular: Are there cells in tumors as they grow in their natural environment which are protected from radiation injury by being short of oxygen? If there are such cells, are they able to regrow the tumor after irradiation, and what is their influence on the dose of radiation required to sterilize a tumor and cure a patient? In a model in which a cylinder of cells was surrounded by stroma bearing capillaries with equal and parallel flow, it was calculated that oxygen tension would be 0 at the center of a cylinder of 145 μ radius. Maps were made of the intact and necrotic areas seen in serial sections of the experimental sarcoma RIB_5 (used for irradiation experiments), when these tumors were about 9 mm in dia, the size used for irradiation. It was calculated that a single layer of cells lining the interface between intact and necrotic tissue would comprise ~1% of all the cells in the tumor. Thus there is evidence that any tumor which develops necrosis may contain cells which are protected from radiation injury by anoxia. The ability of tumor cells to divide and reproduce in their own natural environment after irradiation, is discussed. Survival curves of irradiated tumor cells are examined as a means of determining cancerocidal doses of radiation under various conditions. (TCO)

16471 INFLAMMATORY REACTION IN ULTRAVIOLET INJURY. Logan, G.; Wilhelm, D. L. (Univ. of New South Wales, Sydney). Brit. J. Exp. Pathol., 47: 286-99(June 1966).

The time-course of the early vascular events induced by uv injury in guinea pigs, rats, and rabbits is described, and evidence that the late permeability response is not mediated by the accompanying tissue leukocytosis is presented. In all species the duration of uv irradiation was mainly determined by the minimal exposures required to evoke consistent permeability responses. Each species displayed a diphasic permeability response consisting of early and late phases, separated by an interval in which permeability approximated to the normal low level. The early response was followed by a phase of low permeability. Erythema varied in each species. Although the late permeability response closely followed the onset of leukocytosis, the response was unaffected in animals rendered neutropenic with nitrogen mustard. In rats, leukocytosis closely succeeded the development of the late permeability response, but the neutrophil infiltration appeared to be particularly related to sites that later exhibited sloughing. In rabbits, the leukocytosis also appeared to be related to the impending onset of frank necrosis. The late permeability response became maximal in about 24 hr, whereas leukocytosis subsequently increased to reach a peak in 48 hr. (BBB)

16472 VASCULAR PERMEABILITY CHANGES IN INFLAMMATION. I. THE ROLE OF ENDOGENOUS PERMEABILITY FACTORS IN ULTRAVIOLET INJURY. Logan, G.; Wilhelm, D. L. (Univ. of New South Wales, Sydney). Brit. J. Exp. Pathol., 47: 300-14(June 1966).

The mediation of the permeability responses in uv injury was studied by testing the effects of antagonists of various permeability factors on the early and late permeability responses that characterize this and other types of injury. Permeability changes were indicated by the exudation of circulating Evans blue in the uv-injured skin sites. The early response appeared to be mediated by histamine in the guinea pig and by 5-hydroxytryptamine (5-HT) in the rat, the response being strongly suppressed by corresponding antagonists in both species. In the rabbit, the early response was insusceptible to antihistamine, and its mediator was not identified. In none of these species was the mediator of the late response established. In the guinea pig, antihistamines strongly suppressed the permeability effects of local histamine for at least 2 hr, but repeated systemic or local doses did not decrease the late uv response. Suppression of the early response by antihistamine also did not affect the late phase of increased permeability. The late response in guinea pigs was also unaffected by local doses of the trypsin inhibitors from soya bean, lima bean, potato, and ovomucoid given before uv irradiation or in lesions 3 to 21½ hr old. Other preparations which had no substantial effect on the late response included ϵ-aminocaproic acid, a glucose analogue (2-deoxy-D-glucose, α-amylase, sodium α-naphthyl acetate, and a bovine polypeptide preparation (Trasylol) which antagonizes both callicrein and trypsin. In the rat, the investigation of the late response was confined to the possible role of histamine and 5-HT. The response was unaffected by a 5-HT antagonist, but moderately suppressed by antihistamine. The late response was not investigated in the rabbit. Of all the preparations tested in guinea pigs, none appeared to affect erythema in the irradiated sites. (BBB)

16473 EFFECTS OF IRRADIATION AND ANTIGENIC STIMULATION ON CIRCULATING HAEMOPOIETIC STEM CELLS OF THE MOUSE. Barnes, D. W. H.; Loutit, J. F. (Medical Research Council, Harwell, Eng.). Nature, 213: 1142-3(Mar. 18, 1967).

It is stated that successful therapy is possible with heavily x-irradiated mice by intravenous injections of cell suspensions containing components which act as seed for the recolonisation of myloid and lymphoid tissues. The various cell lines (erythrocytic, granulocytic, thrombocytic, lymphocytic) may be restored by their respective precursors (polyphyletic hypothesis) or be derived by differentiation from a common multipotent cell (monophyletic hypothesis). In either case the precursor is referred to as a stem cell. These cells are present in circulating blood of normal mice, since their leucocytes in sufficiently large number can recolonise lethally irradiated mice and produce spleen colonies. The concentration of colony forming units in peripheral blood is about 10^{-6} that in bone marrow. The present communication is concerned with studies of these circulating colony forming units in mice under special circumstances. It was found that colony forming units, present in normal circulating blood of mice in concentrations of about 10 per CC, were not detectable after sub-lethal doses of x-rays until after about 10 days. They were then present in normal, and sometimes increased, concentration. In mice given an immunising injection of a mixture of pertussis vaccine and calf serum the concentration of colony forming units in blood was increased temporarily to a peak value of more than ten-fold after 7 days, but returned to normal within 3 weeks. It is suggested from these and other observations that these colony forming units may be multipotent stem cells exported from myeloid tissue to colonise lymphoid tissue, where they are committed to lymphoid differentiation. (UK)

16474 EFFECTS ON THE HEARING OF PATIENTS TREATED BY IRRADIATION IN THE HEAD AND NECK AREA. Dias, Alfredo. J. Laryngol. Otol., 80: 276-87(Mar. 1966).

The relevant literature is reviewed and 29 patients treated by irradiation therapy for tumors in the head and neck area were studied to evaluate its effects on their ears and hearing. These patients received a total max dose to the tumor-bearing area of 1000 to 18,000 R. The local dose at the ear varied from 700 to 10,000 R. Subjectively, only one patient complained that hearing had worsened with treatment (average decrease of 3.4 db affected the hearing in the speech range). All others, including 5 who had had fluctuations in their hearing, either felt no changes or experienced subjective improvement in hearing with the treatment, despite some audiometric evidence of deterioration in a few instances. Only one patient complained of tinnitus during the treatment which disappeared soon afterwards, and in another this symptom, which was present before treatment, remained unchanged. No patient complained of vertigo. There were practically no changes in the auricles, meatal skin, or tympanic membranes after the completion of treatment, except in one patient with a glomus jugular tumor in whom the irradiated side showed erythema in the auricle and edema of the floor of the ear canal during treatment. Dryness and desquamation of the auricle and meatal skin with increased pigmentation were present after completion of treatment. A threshold shift of about ±10 db was observed selectively in some individuals. Hearing disturbances, most commonly of the mixed type, appeared to be chiefly related to dysfunction of the Eustachian tube consequent on the presence of the tumor and the changes occurring in it and its adjacent tissues following irradiation. Some patients still showed entirely serviceable hearing after very high doses years after the end of treatment. (BBB)

16475 ON THE IMPORTANCE OF BEAGLE SIZE ON RESPONSE TO WHOLE BODY 1000 kVp X-IRRADIATION. Maillie, H. D.; Quinlan, W. J.; Mermagen, H.; Reilly, J. F. (Univ. of Rochester, N. Y.). Health Phys., 13: 253-7(Mar. 1967).

It cannot be assumed that the whole body irradiation of a group of beagles to the same midline air exposure results in the same stress to each animal. Previous phantom studies have demonstrated that the average exposure measured through the beam center is significantly less for larger dogs. Body contour and tissue composition may make similar measuremements extended throughout the whole body of the dog differ from those found in a homogeneous rectangular phantom. Five beagle cadavers of varying sizes were exposed to 1000 kVp x radiation and the effective photon energies and exposures were measured at twenty-three selected organ locations throughout each animal. Data are presented which demonstrate the relationship between animal size and average organ exposure. One difference noted between these cadaver measurements and previous theoretical or phantom studies was the leveling off of both photon energy and average organ exposures with increasing thickness in the upper torso. This is thought to be due to the increasing lung volume in the larger dogs which, relatively speaking, decreases the scattering and absorbing mass within this segment. Total body average exposure for various animal thicknesses was compared with survival data and, from this, the dependence of expected lethality vs. size for three midline air exposures was determined. (auth)

16476 CLINICAL OBSERVATIONS ON GRID IRRADIATION. Kaneda, Hiromu; Maeda, Mirimasa; Oku, Takayuki; Tanikawa, Kazuo (Kyoto Prefectural Medical Coll.). Strahlentherapie, 124: 366-71(July 1964). (In German).

Depth dose curves indicate that during sieve irradiation the skin beneath the shielded portion of the sieve receives 4800 R when the incident dose is 20,000 R. This dose is the max tolerable for skin. Under these conditions, although the capillaries are destroyed, the skin structure remains intact. Irradiation of ear muscles of guinea pigs with 7000 R was tested with a sieve irradiator with an opening ratio of 40%. With an opening of 2 cm considerable obstruction and destruction of blood vessels was observed 70 days after irradiation. The smaller the dia of the openings the less the skin injury was. With an opening of 0.5 cm a hyperemia was the only reaction observed in the vessels located beneath the openings of the sieve. The effect of the x radiation on the skin was not related to the distance between 2 protected areas, but upon the size of each opening The field size factor plays as large a role in sieve irradiation as in x irradiation of a single small field. The reduced effects of sieve irradiation on skin may be due to geometric considerations that favor histological regeneration of the skin volume irradiated. When doses equivalent to conventional x irradiation of from 400 to 3600 R were administered to various animal skins with equivalent doses for sieve irradiation of 1000 to 9000 R (physical) and 1950 to 14,400 R (biological), the biological sieve effect ratio was from 1.08 to 1.6. (BBB)

16477 FALSE ANEURYSM OF THE VERTEBRAL ARTERY: A COMPLICATION OF RADON SEED IMPLANTATION: CASE REPORT AND MERIT OF ANTEROLATERAL APPROACH. Early, C. B.; Shuring, A. G.; Hunt, William E. (Ohio State Univ. Hospitals, Columbus). Ann. Surg., 164: 900-4(Nov. 1966).

Complications of Rn seed implants are reviewed, and a new case, representing a false aneurysm of the vertebral artery at the level of the axis vertebra, is reported. The history, roentgenograms, and surgical treatment for this complication of Rn implantation are described. Reported complications of Rn seed implantation are rare; however, the disintegration products of Rn in the seeds emits measurable radiation for many years. Late effects may therefore occur for decades. Most reported complications have been fistulas following uterine implants. Use of Rn seed implants in the head and neck may also cause late complications. Ulceration and underdevelopment of the face also have been reported. In the new case reported, the 46-yr-old woman, at the age of 16 was treated for a sarcoma of the pharynx with 20 Rn seeds, each about 1 mCi, implanted into the mass. The total tumor dose was calculated to be about 2660 mCi-hr. At intervals over the next 6 months the patient also received external x-ray therapy: 2250 R to the right lateral neck and 1250 R to the left lateral neck. Two months after Rn seed implantation, the mass had disappeared. Twenty years later, severe hemorrhage of the posterior pharynx occurred, at the site of the implants, and surgery was required. The mass of scar tissue found at operation surrounding the aneurysm was typical of postirradiation scarring and unlike the retracted linear scarring seen after resolution of an infectious disease process. It is believed that this case of false aneurysm of the vertebral artery is a complication of Rn seed implantation. (BBB)

16478 MITOTIC ACTIVITY OF FIBROBLASTS AND MYOBLASTS CULTURED IN VITRO IRRADIATED WITH ^{60}Co. Pagani, P. A.; Lullini, I. Galliani (Univ., Bologna). Boll. Soc. Ital. Biol. Sper., 42: 145-6(Feb. 28, 1966). (In Italian).

Some preliminary experiments are reported on the effects of ^{60}Co γ radiation on the growth of chick embryo fibroblasts and myoblasts. This was done by placing pearls of ^{60}Co on a mica support near the cultured cells for periods from ½ to 96 hr. The source provided a dose rate of 4 R/min at a distance of 0.5 cm. The cells were maintained at 37° C during irradiation and immediately fixed and stained with hemotoxylin after irradiation. The cultures were 16 to 72 hr old at the beginning of irradiation. Estimations were made of the number of mitoses on the basis of the area of migration of the cultured cells. In 31-hr cultures irradiated for ½ hr, the number of mitoses/mm^2 was increased 27% over the unirradiated cultures. At exposures of 1 hr or longer (240 R or more) the number of mitoses was markedly inhibited: 39% of normal for 29-hr cultures exposed for 1 hr, 22% for 19-hr cultures exposed for 1 hr, 9% for 48-hr cultures exposed for 4-hr, and 0% for 42-hr cultures exposed for 12 hr. No mitoses were observed in cultures exposed for 29, 72, or 96 hr. (BBB)

16479 ACUTE BILATERAL FATAL RADIOTHERAPEUTIC LUNG AFTER MINIMAL UNILATERAL COBALT THERAPY. Migueres, J.; Combes, P. F.; Fabre, J. (Centre de Pneumophtisiologie de Purpan, Toulouse). J. Franc. Med. Chir. Thorac., 19: 667-79(Sept.-Oct. 1965). (In French).

A fatal reaction to ^{60}Co irradiation for lung cancer in a 66-yr-old woman is described. Treatment was given for an anaplastic small-cell epithelioma. Because of the patient's poor general state initially, she was treated with Endoxan and corticosteroids. Partial regression of the tumor occurred so that a program of telecobalt therapy was instituted. However, because of the patient's intolerance to it, only four irradiation sessions (150-R air dose in each) were carried out, over 3 anterior and 1 posterior field of 90 cm^2. The total tumor dose was estimated to be 300 rad. Pulmonary function steadily declined, with rapidly progressive dyspnea, death occurring 40 days after the last irradiation session on account of acute respiratory insufficiency. Radiographs of the irradiated lung showed a fine reticular-nodular pattern bilaterally. At autopsy, the irradiated lung showed increased density and microscopically the alveolar architecture was enlarged. The septa were thickened and sclerotic, a fibrillar, cell-free structure predominating. Capillaries were dilated, and elastic fibers fragmented but no giant cell reaction was evident. Arteries showed endothelial hyperplasia. It is emphasized that radiographic and histologic results revealed bilateral lesions whereas only the right lobe was radiated with a relatively low dose. Possible pathogenic mechanisms are considered, but no adequate explanation could be provided for this phenomenon. (BBB)

16480 RESISTANCE OF THE ALLERGIC CONTACT DERMATITIS SENSITIZATION REACTION TO WHOLE-BODY X RAY IN THE GUINEA PIG. Schipior, P.; Maguire, H. C. (Univ. of Pennsylvania, Philadelphia). Int. Arch. Allergy Appl. Immunol., 29: 447-52(1966).

The effect of whole-body x-ray exposure on the acquisition of delayed type hypersensitivity (dinitrochlorobenzene, DNCB, allergic contact dermatitis) in the guinea pig was studied under a variety of experimental circumstances. Animals were topically sensitized by pipetting 1 mg in 0.5 ml acetone on to skin. Sensitivity was measured via the challenge reaction to a nonirritating concentration of DNCB. In the first of two series of experiments, 250 R resulted in a 30-day mortality of 65%; in the second the dose was reduced to 200 R with a consequent decline in mortality to 45%. Such near lethal wholebody x irradiation, whether given before or after sensitization, failed to depress the subsequent challenge responses. To determine whether systemic x-ray exposure speeded or impeded the allergic sensitization reaction, guinea pigs were DNCB sensitized 24 hr after 200-R whole-body irradiation. DNCB challenge tests were negative on days 4 and 5 but positive on day 6 in both irradiated and control groups. There was no evidence of delay or acceleration in the acquisition of the DNCB sensitivity under the conditions of these experiments. The acquisition of delayed hypersensitivity appears less radiosensitive than that of the classical primary antibody response. It has been previously argued that the delayed hypersensitivity challenge response is markedly depressed by lymphopenia. However, the authors previously could find no specific attenuation of the challenge response to DNCB in already sensitive guinea pigs made leukopenic by x ray or cyclophosphamide, and the experiments reported here emphasize this finding. These experiments point up the failure of lymphopenia to depress the ability of the experimental animal to acquire allergic contact hypersensitivity. Lymphopenic guinea pigs can be sensitized to DNCB as well as, or perhaps better than, normal guinea pigs. (BBB)

16481 THE BLASTOMOGENIC EFFECT OF 120-MeV PROTONS. Streltsova, V. N.; Moskalev, Yu. I. Radiobiologiya, 6: 660-5(1966). (In Russian).

In order to study the blastomogenic effect of 120-Mev protons in the dose range of 10 to 800 rad, Wistar rats were irradiated once with protons from an OIYal synchrocyclotron. The dose rate was 0.3 rad/sec. Experimental results showed that in proton-irradiated rats the frequency of appearance of both benign and malignant tumors in the following tissues was higher than in controls: mammary glands, hemogenic tissue, thyroid gland, adrenals, hypodermic tissue, kidneys, bones, uterus, thymus, and prostate gland. It was observed that in female rats the incidence of tumors and of multiple neoplasms was considerably higher in both irradiated and control groups than corresponding rates for male rats. The high incidence of neoplasms in females may be connected with the sensitivity of mammary glands, hypophysis, ovaries, and uterus to tumor formation. More mammary tumors appeared in female rats irradiated with 50 to 600 rad, and tumors developed faster than in controls (7 mo in experimental animals and 12 mo in controls). The incidence of leukosis in irradiated males and females (doses 200–400 rad) increased to 11.4%, as compared with 1.7% in controls. It was established that the dose required to double the spontaneous incidence of leukosis in rats was 50 rad. The highest incidence of pituitary tumors in female rats (34.3%) was observed with radiation doses of 200 rad; the highest incidence for males was 42% (50 rad). With doses above these levels, the incidence of pituitary tumors dropped in both males and females. Incidence of adrenal tumors increased with 100 rad of protons or more; thyroid tumors, 25 to 50 rad; kidney tumors, 600 rad, and tumors of the gastrointestinal tract, 100 to 600 rad. (ATD)

16482 STUDIES OF CARCINOGENESIS IN PARABIOTIC RATS. Sommers, Sheldon C.; Friedell, Gilbert H. (Francis Delafield Hospital, New York. New England Deaconess Hospital, Boston). Contract AT(30-1)-901. Ann. N. Y. Acad. Sci., 125: 928-32(Jan. 21, 1966). (NYO-901-27).

The ovarian tumors that developed in parabiotic rats following supralethal irradiation of one partner have been reviewed. A majority were classified as Sertoli-cell tumors and the next most frequent type was the granulosa-theca-cell tumor. Epithelial tumors were rare. The pathogenesis of these tumors was felt to involve destruction of primordial ova and follicles by irradiation, followed by regeneration, hyperplasia, and neoplasia of a previously indifferent gonadal stroma. (auth)

16483 CHANGES IN THE RESPIRATORY TRACT AND INTESTINE FOLLOWING SINGLE WHOLE-BODY IRRADIATION WITH SUBSEQUENT OPERATION ON THE SMALL INTESTINE. Tsagareishvili, A. V. Eksp. Khir. Anesteziol., 8: 30-1(July-Aug. 1963). (In Russian).

Dogs weighing about 6 kg were given 400-R whole-body doses of radiation. Irradiated animals endured cold badly; when exposed to cold, acute pneumonia, mediastinitis, and hemorrhagic gastroenteritis subsequently developed. With special postoperative care (keeping the animals in warm, clean quarters with application of symptomatic medication), the irradiated dogs endured surgery (intestinal anastomosis) comparatively well in the first days after irradiation. Symptoms of radiation sickness appeared 7 to 9 days from the time of irradiation, and a relapse from the after-effects of irradiation appeared on the 15th and 26th day postirradiation or later. Healing of the surgical incision on the abdominal wall and in the intestinal anastomosis in these dogs was delayed. At autopsy, the intestinal wall in the region of the anastomosis was edemic and hemorrhagic foci had developed in thicker layers of tissue, and at later periods of observation it was noted that areas of necrosis had developed around the intestinal sutures. (BBB)

16484 EXPERIENCE WITH TOTAL LARYNGECTOMY AFTER COBALT THERAPY. Poncet, P. Ann. Otolaryngol. (Paris), 82: 374-80(Apr.–May 1965). (In French).

Problems encountered in surgical removal of the larynx after irradiation of the region with ^{60}Co are described with reference to 30 cases. It is important to evaluate the effects of irradiation on the tissue before surgical intervention so that some of the severe complications, such as hemorrhage, can be prevented. All the patients received a curative preoperative tumor dose of 6500 to 7500 R distributed over 35 days. Usually, two 4 × 5 cm lateral fields were used, centered over the vocal cords. Surgical intervention was necessitated by persistence of the tumor and was delayed 1 to 3 months postirradiation. Complications are described. In four cases wound healing was retarded as a result of irradiation and fistulization occurred. Four cases required a pharyngostomy, two other patients developed hemorrhage from the jugular vein which was fatal. Ways in which these complications of preoperative irradiation may be prevented are discussed. Large doses of penicillin (10 to 20 million units per day) were found to be effective, more so than a penicillin-streptomycin combination, in treating radionecrosis. Delicate surgical techniques are necessary in handling the radiation-devitalized tissues. Fatal hemorrhage followed extensive cervical lymph node dissection in one case. (BBB)

16485 IMMUNOLOGICAL STUDIES ON NIPPOSTRONGYLUS BRASILIENSIS INFECTION IN THE RAT: EXPERIMENTS WITH IRRADIATED LARVAE. Prochazka, Zd.; Mulligan, W. (Univ. of Glasgow). Exp. Parasitol., 17: 51-6(Aug. 1965).

The x-ray treatment of the infective N. brasiliensis larvae leads not only to a reduction in the total number of worms which develop from a standard dose of larvae, but also to differences in their distribution between lungs and small intestine. Irradiated preparations of N. brasiliensis were used to investigate the relative immunological importance of the lung and intestinal phases of infection. The development in rats of larvae treated with x-ray doses of 0, 50, 100, and 180 kR was studied. The intestinal burdens at day 10 from 2000 larvae so treated were, respectively, 855, 800, 103, and 0; the lung burdens at the same time were 17, 19, 32, and 94. Larvae treated with x-ray doses of 50 and 100 kR conferred as good an immunity as normal larvae, but larvae

treated with 180 kR had little or no immunogenic action. Differences in the degree of attenuation produced by the same dose of x rays on different preparations of N. brasiliensis larvae may have been associated with differences in inherent infectivity of the larvae. Although with a suitable dose of x rays a preparation of N. brasiliensis larvae can be obtained which gives rise to no worms in the small intestine at day 10, such a preparation seems to have little immunogenic power. This indicates that the intestinal phase is of great immunological importance. (BBB)

16486 RADIOCANCEROGENESIS AND THE PROBLEM OF RESTORATION. Moskalev, I. I.; Streltzova, V. N. (Inst. of Experimental Oncology, Moscow). Biol. Med. (Paris), 54: 428-39 (July-Aug. 1965). (In French).

A study was made of the frequency of osteosarcoma and leukemia in rats given repeated intraperitoneal injections of ^{144}Ce, ^{90}Sr, and ^{239}Pu. A total of 526 rats were tested. Osteosarcomas developed in 99 rats (51 with ^{144}Ce, 31 with ^{90}Sr, and 17 with ^{239}Pu). Leukemia developed in 33 rats (18 with ^{144}Ce and 15 with ^{90}Sr). Thus of rats which received daily injections of ^{90}Sr for 100 days (total of 100 μC), 16% presented leukemia. However, when ^{90}Sr was injected at intervals of 2 to 4 weeks to give the same total dose, only 7 and 9%, respectively, developed leukemia. Similar effects of more intensive treatment were seen with ^{144}Ce; daily injections gave sarcomas in 60%, injections every two weeks in 40%, and every 4 weeks in 31%. Injection of a single dose (1.25 $\mu\mu$C) of ^{239}Pu gave osteosarcomas in 3% of the rats, whereas 50 or 100 daily injections (same total dose) gave an incidence of 14.2 and 11.1%, respectively. Thus, protracted treatment with Pu is more effective, contrary to results with the other two isotopes. Variations in histologic findings in hematopoietic tissues under the effect of the isotopes are described. These results indicate that repair processes are involved in this phenomenon and that the frequency of tumors induced and their degree of differentiation vary according to the time course of the injections. (BBB)

16487 EXPERIMENTAL STUDIES ON IRRADIATED PERIPHERAL NERVE AND DIGITAL JOINT HOMOGRAFTS IN MONKEYS. Ashley, F. L.; McConnell, D. V.; Machida, R.; Stone, R.; Polak, T.; Delabar, M. (Univ. of California, Los Angeles). pp 355-61 of Trans. 3rd Intern. Congr. Plastic Surg., Oct. 13-18, 1963. Washington, D. C. Amsterdam, Exerpta Medica Foundation, 1964.

Studies were conducted in the Rhesus monkey and Japanese ape with ulnar and median nerve segments 3-cm long obtained from sacrificed animals which were frozen and irradiated with 1.5 M = rad. They were then stored in sterile plastic envelopes at −70°C for periods up to 3 months. The recipient animal grafts were inserted in the ulnar and medium nerves. For a control group, frozen nonirradiated nerve homografts were used. Millipore-microweb was applied around the nerve graft to evaluate the influence of an artificial sheet on the healing and regeneration of the grafts. Results in homografted recipients were assessed functionally and by pain, touch, and heat reaction, and direct nerve stimulation with galvanic current. Histological examination of the homografted nerve segments and proximal and distal fragments of host nerve bridged by the homograft was recorded by photomicrographs. The results indicated that short irradiated homografts are successful in monkeys. It is suggested that banked, irradiated human nerve may be effective in the immediate or delayed repair of peripheral nerve defects. (TSS)

16488 EFFECT OF IONIZING RADIATION ON THE OVARIES OF JAPANESE MEDAKA, ORYZIAS LATIPES (T. ET S.). Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Acta Anat., 63: 434-4(1966).

The female fish were irradiated with 32,000 R of x rays. The LD_{50} was reached within 4 to 5 days. The youngest and completely mature oocytes were very radiosensitive and destroyed soon after irradiation with 32,000 R. In younger oocytes, the nuclei became pyknotic. Nucleoli were also radiosensitive; they were reduced in number and became swollen and vacuolated. Two days after irradiation, nuclei showed chromatolysis. In some instances the follicular epithelium hypertrophied. Four days after irradiation most of the oocytes seemed to be abnormal and degenerating, but a few larger oocytes appeared to be normal. Six days after irradiation, the ovarian tissue was completely degenerated. The mean weight of the ovaries declined from 70.0 mg to 22.9 mg 6 days after irradiation. Immediately after irradiation the number of eggs laid declined greatly. The ratio of viable and nonviable eggs was 1.1 : 1.3 on the first day, 1.9 : 2.5 on the second day, 7.1 : 2.4 on the third day, 11.1 : 2.1 on the fourth day, 8.5 : 3.0 on the fifth day, and 1.5 : 1.0 on the sixth day. In the irradiated ovary there was a significant increase in the number of atretic follicles. The follicular epithelium showed typical hyaline degeneration after irradiation. (BBB)

16489 EFFECT OF RADIATION ON THE COURSE OF SOME SOMATIC DISEASES. Polenko, V. K.; Donskoy, M. D.; Zhisamutdinov, G. K. Voenno-Med. Zh., 2: 31-6(Feb. 1965). (In Russian).

More than 600 patients aged 18 to 70 years, who had undergone radiation therapy for various types of tumors in various sites, syringomyelia, thyrotoxicosis, some diseases of the hematopoietic system, and others, were studied. Of the 600 patients, 263 were women and 359 men. Treatment consisted of 200-kv x rays or ^{60}Co γ rays. Patients with thyrotoxicosis were treated with ^{131}I in doses of 2 to 3 mC at intervals of 5 to 7 days between injections (total dose 6 to 12 mC). Patients with polycythemia received radiophosphorus ^{32}P in doses of 2 to 3 mC at intervals of 5 to 7 days to total doses of 8 to 12 mC. Metabolic and functional changes affected by irradiation were noted. Under the effect of irradiation some disease symptoms worsened, requiring active therapeutic intervention. In the initial period of radiation therapy symptoms of thyrotoxicosis were aggravated, with imbalance of carbohydrate metabolism, coronary insufficiency, and diminished function of the myocardium; chronic inflammation of the lungs and digestive tract became acute; and the reactivity in allergic diseases increased. Diseases of the blood system of a neoplastic nature were transformed to more malignant forms. It is necessary to foresee these possible changes in the course of an underlying or accompanying disease during radiotherapy, so as to undertake timely, sufficiently effective therapeutic measures when they are required. (BBB)

16490 OCCUPATIONAL AND ENVIRONMENTAL CANCERS OF THE RESPIRATORY SYSTEM. Hueper, W. C. Recent Results Cancer Res., 3: 1-214(1966).

Carcinogenic effects of ionizing radiation on the lung are considered, including a discussion of the technological and epidemiological aspects, incidence of lung cancer in uranium miners and uranium-processing workers. Worker groups and population groups that become affected to an exceptional degree because of employment in occupations entailing the production of radioactive materials or on account of their exposure to radioactive matter and ionizing radiations released by the detonation of nuclear devices are also considered. The increasing use of ionizing radiations in medicine for diagnostic and therapeutic purposes has added to and intensified these exposures for many individuals, with the appearance of a rapidly rising number of cancers in man affecting a variety of organs and tissues that depend on the specific type of radioactive materials active and upon their external or internal route of exposure. Such radiation cancers have been induced as the result of occupational, cosmetic, dietary, medical, military, and environmental exposures. Organs of respiratory system become involved whenever gases or dust emitting ionizing radiations are inhaled or radioactive matter is directly introduced into the ducts and cavities of the respiratory tract or when penetrating ionizing radiations act from the outside upon respiratory organs. Respiratory cancers in radioactive-ore miners and millers are surveyed, as applied to radioactive, nonuranium miners, in Schneeberg miners, uranium ore miners, and Joachimsthal miners. The degree of atmospheric pollution with radioactive matter in the Joachimsthal mines was 30 times the tolerance dose, and more than half of the miners died of lung cancer. Incidence of lung cancers in uranium ore miners of the Colorado Plateau is examined in detail. It has been found that the mean number of months of underground experience and the mean dose rate of these miners with respiratory cancer were greater, though not significantly so, than those of other groups used for comparison. The value of these observations is accentuated by the fact that there was a significant excess of respiratory cancers even among uranium miners with no prior hard-rock mining experience. (BBB)

16491 INDUCTION OF NUCLEAR DAMAGE BY IONIZING AND ULTRAVIOLET RADIATION. von Borstel, R. C. (Oak Ridge National Lab., Tenn). pp 243-50 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

To assess radiation effects on the nucleus, the haploid–diploid genetic system of the wasp Habrobracon were studied and the results correlated with data for the fruit fly Drosophila. The value of the haploid cell is in its lack of two genetic complements that would buffer, cover, or alter the radiation effects. Nuclear radiation damage was divided into five classes according to the various syndromes associated with death of the cell or embryo. These are summarized as follows: Type I, death after one or a few nuclear divisions; Type II, death after many nuclear divisions (in Habrobracon characterized by death after blastoderm formation and before hatching in unfertilized eggs, death occurs predominantly after hatching in fertilized eggs); Type III, death

after many nuclear divisions (in Habrobracon death occurs after blastoderm formation and before hatching in unfertilized and fertilized eggs); Type IV, death and pycnosis soon after irradiation (characteristic of lymphocytes, young primary gametocytes, late gonial cells, and neuroblasts); and Type V, dominant lethality expressed in eggs after irradiation in the gonial stage (in Habrobracon, embryo dies late in development). In Habrobracon, the Type-I lethal syndrome can be induced by agents that inhibit meiosis or mitosis. Therefore, depression of the rate of the mitoses following meiosis is a sufficient action of the radiation to bring about the Type-I lethality syndrome. Type II lethality can be attributed to chromosome imbalance of limited extent. Following treatment of oocytes with ionizing radiation a small consistent fraction of Type-I lethality is repaired when the egg is fertilized with a normal sperm. It seems likely that the Type-I lethality from irradiation of the nucleus can be induced through at least 2 distinct mechanisms, one capable of being reactivated. (BBB)

16492 THE EFFECT OF DIAGNOSTIC AND THERAPEUTIC ROENTGENOLOGIC PROCEDURES ON RENAL FUNCTION. Hall, Jack W.; Childs, Donald S. Jr. (Mayo Clinic, Rochester, Minn.). Med. Clin. N. Amer., 50: 969-77 (July 1966).

Injury to the kidney by radioopaque agents and by radiotherapy is reviewed. Clinically, the renal problems that arise from therapeutic abdominal irradiation may be classified as acute radiation nephritis, chronic radiation nephritis, benign hypertension, and late malignant hypertension. Each of these forms is described. Shielding of the kidneys, the use of modern radiotherapeutic techniques and instruments, and the screening of patients about to undergo abdominal irradiation for preexisting renal disease provide some protection against radiation-induced renal disease. (BBB)

16493 STUDIES OF THE MECHANISM OF ULTRAVIOLET ERYTHEMA FORMATION. IV. THE HISTAMINE CONTENT OF THE SKIN DURING THE PROCESS OF ULTRAVIOLET AND THERMAL ERYTHEMA. Valtonen, Erikki J. (Univ. Central Hospital, Helsinki). Acta Dermato-Venerol., 46: 301-6 (1966).

Development of erythema in the ear skin of mice, and the accompanying changes in skin histamine content, was examined using long and short wavelength uv radiation (uv-B and uv-C, respectively) and heat. The histamine content of the skin was determined at various phases of the erythema process, development, max point, and fading of the erythema. The development and fading of the erythema was observed during the whole time and the degree of the erythema was recorded according to a special scale. Histamine content of the skin samples was determined at intervals of 4 hr. In addition, the effect of a lamp which caused only thermal injury in the skin was studied. The histamine content of the tissues did not change during the erythema process. This was the same for both wavelengths (uv-B and uv-C). On the contrary, burning of the skin associated with uv erythema caused a significant decrease in the histamine content of the skin when the histamine was calculated per weight unit of tissue. This decrease, however, was not a real one and was due to inflammatory edema. When the amount of histamine was calculated per ear tip, no change was observed. (BBB)

16494 THE ULTRASTRUCTURE OF CANINE ALVEOLI AFTER SUPERVOLTAGE IRRADIATION OF THE THORAX. I. LESIONS OF THE LATENT PERIOD. Leroy, Elie P.; Liebner, Edwin J.; Jensik, Robert J. (Univ. of Illinois, Chicago). Lab. Invest., 15: 1544-58 (Oct. 1966).

To elucidate the mode of development of radiation pneumonitis and to clarify the factors controlling its resolution or organization, the ultrastructural changes induced by irradiation of the right hemithorax of dogs with increasing doses of supervoltage x rays were examined. The 22.5-MeV x-ray beam of a betatron was used to give 500 R to the anterior and to the posterior hemithorax for a total exposure dose of 1000 R, the dose absorbed within the right lung being 850 rad. Higher radiation doses were similarly administered in 1000-R fractions at weekly intervals except for one dog exposed to a total dose of 7000 R delivered in fractions of 1000 R twice a week. In biopsies taken 44 to 96 hr, and examined by electron microscopy, after exposure of the right hemithorax to 850 rad, the alveolar epithelium, the septal cells, and, to a lesser extent, the capillary endothelium showed dilation of the endoplasmic reticulum with discrete rupture of the membranes of the cytoplasm. No significant morphologic change was noted in the cell nucleus. However, some cells were binucleated. Two to 4 weeks following irradiation of the thorax, in addition to the above lesions, cytoplasmic electron-dense bodies mixed with osmiophilic masses were observed in some cells. There was increased cellularity in the blood-air barrier associated with the presence of elongated cytoplasmic processes from interstitial cells. This, together with the increased complexity of endothelial and epithelial cellular junctions and the abundance of microfibrils in the interstitium, was the early evidence of repair. Hyaline membrances were absent. (BBB)

16495 CYTOGENETIC EVIDENCE OF CLONAL PROLIFERATION IN PRIMARY RETICULAR NEOPLASMS. Ford, C. E.; Clarke, Constance M. (Medical Research Council, Harwell, Eng.). Can. Cancer Conf., 5: 129-46 (1963).

Examples are provided of cytogenetic evidence of 3 properties of the neoplastic cell population in its primary host: that it may be generated by proliferation from a single ancestral cell; that variant (though related) cell types may arise within it; and that one of these may replace another as the dominant component of the population during the course of the disease. Clonal proliferation in irradiated mice, which provides a model for neoplastic cell populations, is described. Chromosomal studies of the hemopoietic tissues of mice regenerating after irradiation reveal certain features in common with some neoplastic cell populations. A heavily irradiated mouse soon exhibits extensive destruction of bone marrow, splenic pulp, and lymphoid tissue, but if injected cells are given, a graft of hemopoietic tissue may persist indefinitely, or progressively give place to regenerating host tissue. Chromosomes of such regenerating show abnormalities, which include changes in length, changes in position of the centromere, and the appearance of characteristic new secondary constructions. Apparently the same set of abnormal chromosomes may recur repeatedly in different cells of the same animal; explanations of such observations are discussed. Either a very similar series of changes has taken place many times independently, or the abnormal chromosomes are in fact identical and the cells that bear them are related by mitotic descent from a common ancestor. In view of the known capacity of ionizing radiation to bring about structural changes in the chromosomes and the facts that they are distributed at random as between different chromosome segments, that the observed sets of abnormal chromosomes differ from one mouse to another and sometimes within the same mouse, and that only very few cells survive the irradiation to contribute to the regeneration of the tissue, it is likely that the cells with a common array of abnormalities have a common origin. Each constitutes a clone of cells in vivo. When 2 or more distinctively marked clones are present in the same animals, it can be demonstrated (by transplantation of hemopoietic cells into further irradiated mice) that they have different capacities to proliferate, which may reflect genotypic variation induced by the irradiation. (BBB)

16496 POPULATION DYNAMICS OF DAPHNIA PULEX AS MODIFIED BY CHRONIC RADIATION STRESS. Marshall, J. S. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Ecology, 74: 561-70 (Summer 1966).

Twenty-five self-regulating populations of Daphnia pulex were exposed to different levels of external ^{60}Co γ radiation for 18.5 hr per day for 55 weeks. Dose rates ranged from 0 to 516 R/day. Although the populations at the 3 highest dose rates became extinct, the remaining 22 populations established quasi-equilibrium densities which decreased with increasing dose rate. The maximum tolerable dose rate was 436 R/day. Average turnover rates increased with dose rate. An inverse relation between mean population size and mean turnover rate suggested that net production might be unaffected by irradiation. Estimates of yield to decomposers indicated that net production was unaffected. Radiation stress became a limiting factor for population size and turnover rate at much lower dose rates than those needed to limit net production. Within the entire range of indefinitely tolerable dose rates, the population consequences of radiation stress stem almost entirely from effects on individual fertility and survival, whereas individual metabolism is apparently unaffected. Increased individual growth is an indirect effect, due to reduced fecundity at a given food supply per individual or increased food consumption at a given food supply per population. (BBB)

16497 CUTANEOUS MANIFESTATIONS OF THE CORNELIA DE LANGE SYNDROME. Schuster, Donald S.; Johnson, Sture A. M. (Univ. of Wisconsin, Madison). Arch. Dermatol., 93: 702-7 (June 1966).

Excessive parental exposure to ionizing radiations in a case of this disease is reported. The Cornelia de Lange or Brachmande Lange syndrome is characterized by cutaneous and external manifestations, including hirsutism, cutis marmorata, and a bluish discoloration of the facial skin. The facies is ordinarily typical and readily recognized. Epidermal ridge patterns are often hypoplastic. In addition growth failure, skeletal abnormalities, mental retardation, and abnormal cry are present. Early death usually occurs in these patients. In 1 of the 2 cases de-

scribed, prior to pregnancy the mother had been exposed to a considerable number of diagnostic x-ray exposures for gastrointestinal, dental, and renal studies. She had worked with a fluoroscope for 8 hr per day during the week before marriage. The father had been exposed to radiocobalt in his work at a foundry. No history of parental radiation exposure for the second case is cited. (BBB)

16498 FEATURES SPECIFIC TO THE FUNCTIONS OF THE HIGHER DIVISIONS OF THE CENTRAL NERVOUS SYSTEM IN ANIMALS SUBJECTED TO THE EFFECT OF IONIZING RADIATION AT VARIOUS PERIODS OF ANTENATAL DEVELOPMENT. Plontkovskii, I. A. (Inst. of Higher Nervous Activity, Moscow). J. Comp. Physiol. Psychol., 54: 314-18 (1961).

Function of the central nervous system was examined after in utero exposure of rats and rabbits to 200 and 400 R, respectively, of 200-kv x rays and ^{60}Co γ rays. Conditioned response (CR) of the 45-day-old rats and 3-day-old rabbits was examined as well as their electroencephalographic (EEG) patterns. Observations of the early postnatal ontogenesis in these animals showed a delayed development of their nervous system and, especially, of the cerebral cortex, as a result of which the inhibitory action of the cortex upon subcortical functions becomes manifest at a later date and is less strong. There was a rise of spontaneous motor activity in the animals and in a prolonged nonextinction of innate subcortical reactions, such as licking and shaking. The behavior of the irradiated rats was often marked by a spontaneously arising aggressiveness to one another and elevated motor excitability. The study of the CR activity also demonstrated a diminished intensity of the basic nervous processes. Positive CRs in the irradiated animals appeared sooner than in controls, but their formation took longer and sometimes failed altogether. This was due to the weakness of the excitation process, also manifested during functional tests. The EEG of the antenatally irradiated animals showed a tendency toward monorhythmia, i.e., the EEG frequency range in experimental animals was considerably narrower than in normals. Morphologic examination of the brain of animals subjected to ionizing irradiation at different periods of antenatal development revealed some common traits; viz., diminution of the total cerebral mass, thinning of the cortex, underdevelopment of the corpus callosum and hippocampus, and disturbance of synaptic connections. (BBB)

16499 USE OF RETICULOENDOTHELIAL FUNCTION FOR STUDYING GRAFT-VERSUS-HOST REACTION IN THE PRESENCE OF POTENTIAL HOST-VERSUS-GRAFT REACTION. Howard, J. G. (Univ. of Edinburgh). J. Reticuloendothel. Soc., 1: 29-39 (Jan. 1964).

The graft-vs-host (GVH) reaction was followed in adult F_1 hybrid mice by measuring stimulation of the phagocytic index K. The reaction developed in two situations in which the antigenic stimulus to GVH was strong while a weak antigenic stimulus to host-vs-graft (HVG) was also present (the latter in the form, in one case, of the male-specific antigen, and in the other of the non-H-2 antigens by which strains CBA and C3H differ). The phagocytic response was inhibited by pre-immunization of the recipient against these weak antigens. With the non-H-2 antigens the effect was intensified by pre-immunization of the donor or sublethal x irradiation (200 to 350 R) of the recipient. The subsequent reactivity of the recipients to the foreign donor antigens was assessed by skin grafting. In the case of male-specific antigen, tolerance was induced, even when spleen cells were given 8 days after skin grafting. In the case of the CBA $\rightarrow$ (C57BL $\times$ C3H)F_1 combination, immunity was found, unless the recipients had been pre-irradiated (350 R) when tolerance resulted. It is concluded that a strong GVH reaction can develop against a weaker HVG reaction, without tolerance being induced. (BBB)

16500 APPLICATIONS OF ELECTRON SPIN RESONANCE IN THE STUDY OF RADIATION EFFECTS IN VIVO. Gherman, Cornelia; Holan, T. (Sectia de Medicina Nucleara, Cluj). Fiziol. Normala Patol. (Bucharest), 11: 365-70(July-Aug. 1965). (In Rumanian).

The effects of total x irradiation in rats were studied. The concentration of free radicals in lyophilized spleen of animals sacrificed a few minutes, 24 hours and 3 days after irradiation was examined. The number of spins per g tissue was found to be as follows: unirradiated animals, 6.2×10^{17}; constant throughout the examination period; irradiated animals, unprotected; several minutes, 17×10^{17}; 24 hours, 16×10^{17}; 3 days, 22×10^{17}; unirradiated animals, after intraperitoneal administration of cysteine (7.5 mg/100 g), few minutes, 14.2×10^{17}; 24 hours, 11.5×10^{17}; 3 days, - ; irradiated animals, treated with cysteine 20 min before irradiation: several minutes, 11.5×10^{17}; 24 hours, 11×10^{17}; 3 days, 10×10^{17}. The radiation dose (lethal) was 700 R, given at a rate of 40 R/min. Possible mechanisms are discussed for the radiobiological effect and the chemical protective effect. (BBB)

16501 THE HOST RESPONSE OF IRRADIATED MICE TO EHRLICH'S ASCITES CARCINOMA. Thunold, Svein (Univ. of Bergen, Norway). Acta Pathol. Microbiol. Scand., 68: 37-46 (1966).

Previous studies on the influence of host immune response on the intraperitoneal growth of Ehrlich's ascites carcinoma (EAC) have indicated that homotransplantable tumors elicit an immune response but that they grow in spite of this. Experiments were performed to test the role of this presumed host immune response in the cytology and intraperitoneal growth of EAC, total-body irradiation being used to modify this response. An x-ray dose of 300 R was chosen because it is sufficient to depress or delay antibody response to bacterial agents, and to homografted tumors. The 300-R dose given to mice was consistently nonlethal and caused no weight loss. The cytological findings supported the previous suggestion that the tumor cells become antibody-coated during growth in normal mice. In the irradiated mice such cytological changes indicative of an immune response were not found. The amount of blood in the tumor-induced ascites fluid was increased in the irradiated mice, probably due to irradiation effect on blood coagulation. The amounts of tumor and cell-free fluid were similar in the 2 groups. It is concluded that the immune response of the recipients did not affect the intraperitoneal growth of EAC under these conditions. (BBB)

16502 TOTAL PROTEIN AND PROTEIN FRACTIONS IN BLOOD SERUM OF OFFSPRING OF IRRADIATED GUINEA PIGS FOR A NUMBER OF GENERATIONS. Osipovskii, A. I.; Shutova, V. S. Tr. 1-go [Pervogo] Moskov. Med. Inst., 41: 129-35 (1965). (In Russian).

Four generations of guinea pigs, progeny of irradiated (450 R) and non-irradiated control guinea pigs, were studied for levels of total protein and protein fractions in their serum. Paper electrophoresis was used to separate protein fractions. The first generation guinea pigs were affected in 2 ways. Firstly, serum protein levels were affected by radioinduced changes in the maternal guinea pig which provided unfavorable conditions for embryonic development. Secondly, mutations may have been produced which could have affected all subsequent generations of guinea pigs from the irradiated parents. The most marked improvement in serum protein levels (total and fractionated) occurred in the first generation animals. In later generations marked deviations from normal levels of some fractions were noted in individual animals. However, these deviations were less in the fourth generation guinea pigs. (BBB)

16503 INTERFERENCE IN MOUSE LEUKEMIA: RESULTS AND PROSPECTS. Latarjet, Raymond (Institut du Radium, Paris). pp 105-12 of Methodological Approaches to the Study of Leukemias. Defendi, Vittorio (ed.). Wistar Institute Symposium Monograph No. 4. Philadelphia, Wistar Inst. Press, 1965.

Attempts were made to determine whether the cell-free extract from a virus-induced tumor, heavily irradiated to eliminate its infectivity, can act as an antineoplastic agent in isologous or homologous hosts when, in parallel, the eradication of the malignant cells is achieved. The system studied was the spontaneous lymphoid leukemia in the AKR mouse. The isologous uv- or x-irradiated cell-free extract was injected during the first 2 months of life. When the dose of radiation was not sufficient to decrease the infectivity of the extract below a certain limit, an enhancing phenomenon was observed: leukemia appeared about 100 days earlier than normal and with a higher frequency. If the extract was inactivated by x rays, no effect was observed. If the extract was irradiated with a dose high enough to suppress the enhancing effect, but not exceeding a certain limit, the frequency of the spontaneous leukemias was decreased. Out of 5 uv-irradiated extracts, 1 was inactive, whereas the 4 others decreased the incidence of leukemia by 12 to 28%. X-rayed extracts, irradiated under indirect effect conditions, were more effective, decreasing the incidence by 30 to 42%. Extracts of normal tissues were ineffective. As a mechanism of this phenomenon, 3 possibilities are considered: (1) Indirect interference. The irradiated extract, injected in relatively large amounts, could induce the synthesis of an interferonlike substance, active against the Gross virus. (2) Steric interference. The radiation-inactivated virus may directly interfere with the active virus, as it does in vitro, at the level of the sensitive cells. (3) Immunological effect. The virus may act as an antigen capable of eliciting or favoring some immunological reactions against those cells which have been transformed by the virus injected at birth. (BBB)

16504 THE ABSENCE OF EFFECT OF X-RAYS ON THE NUMBER OF LARGE NERVE CELLS IN THE MOUSE SPINAL CORD TWO YEARS AFTER IRRADIATION. Wright, E. A.;

Jacobs, Jean M. (St. Mary's Hospital, London). J. Pathol. Bacteriol., 91: 613-15(1966).

To ascertain whether irradiation advances the changes of senescence, a comparison was made of counts of large nerve cells in the spinal cord of unirradiated 2-yr-old mice with those of mice of the same age that had received nearly 500 RAD doses of x rays to the whole-body when they were one month old. Irradiated and sham-irradiated mice were killed at the age of 104 weeks for examination of the nervous system. The mean total nerve count (± the standard error) in the irradiated mice was 6642 ± 224 and that for the control mice 6732 ± 178. This difference was insignificant. It was shown earlier that a whole-body dose of 500 R of x rays given to mice in youth limits their lifespan but the present results show that it does not reduce the number of large nerve cells in the spinal cord. This evidence gives no support to the theory that irradiation has an aging effect on the central nervous system. It was also previously shown that there is a loss of nerve cells in the cords of old mice; thus if radiation was mimicking senescence in the central nervous system, a loss of nerve cells would be expected. Doses of radiation of ~2000 RAD to the central nervous system cause damage that is delayed for many months and the changes that were found were due to damage to the blood vessels. With the dose of radiation given in these experiments no permanent damage to nerve cells could be demonstrated, even when the delay extended throughout almost the whole of the animals' natural lifespan. (BBB)

16505 THE SURVIVAL TIME OF IRRADIATED MICE WITH EHRLICH'S ASCITES CARCINOMA. Thunold, Svein (Univ. of Bergen, Norway). Acta Pathol. Microbiol. Scand., 68: 47-53 (1966).

Survival time and growth of Ehrlich's ascites carcinoma was investigated in normal and x irradiated (300-R) male and female mice. The survival time was decreased in irradiated male mice but not in irradiated females. The irradiated animals of both sexes showed early intraperitoneal bleeding, probably as a result of irradiation damage. This bleeding tendency was most marked in the irradiated male mice and was considered the cause of the decreased survival time in this group. Change in immune response in the irradiated groups, apparently had no direct influence on survival time. The amounts of tumor and of cell-free exudate were decreased in irradiated mice examined at time of death, and so sex differences were demonstrable. The consequences of host reactions to intraperitoneal tumor volume are discussed. It is concluded that slower tumor development in irradiated animals probably is partly attributable to the inhibitory effect of irradiation on inflammatory reactions and partly to anoxic tumor cell damage as a result of an increased bleeding tendency. (BBB)

16506 EFFECT OF MICROWAVE RADIATION ON THE HEMOPOIETIC SYSTEM OF THE RAT. Deichmann, Wm. B.; Miale, John; Landeen, K. (Univ. of Miami, Coral Gables, Fla.). Toxicol. Appl. Pharmacol., 6: 71-7(Jan. 1964).

Hematologic changes occurred in immobilized Sprague–Dawley rats exposed for 7.5 hr to microwave radiation of a power density of 24 mW/cm^2. There was an immediate rise in the erythrocyte count, a rise in hemoglobin, and a drop in the number of total leucocytes. The leucopenia was due to an increase in polymorphonuclear leucocytes and a drop in lymphocytes. Recovery was prompt with regard to erythrocytes and hemoglobin, but 1 week elapsed before the leucocytes had returned to the pre-experimental level. These hemopoietic effects were also encountered following exposure to a relatively low power density such as may be encountered aboard ship, or in personnel engaged in the testing of radar equipment, as well as in people working or living near radar installations. Such exposure of Osborne–Mendel, CFN, and Fischer strain rats to minimal doses of microwave radiation (24,000 Mcps) induced a significant leukopenia, lymphopenia, and neutrophilia after 7 hr of continuous exposure to 20 mW/cm^2 with recovery in 1 week; 10 min of continuous exposure to 20 mW/cm^2; and 3 hr of continuous exposure to 10 mW/cm^2 with recovery in 2 days. Effects on erythrocytes, hemoglobin, and hematocrit differed in the 3 strains used. In Osborne–Mendel and CFN rats, all values increased; in Fischer rats, they decreased. (BBB)

16507 THYROID UPTAKE IN PATIENTS WITH MALIGNANT LYMPHOMAS. Logan, J. W. (Wellington Hospital, New Zealand). J. Coll. Radiol. Austral., 9: 263-5(Oct. 1965).

The effect of irradiation on thyroid function was studied in 68 patients treated for lymphoma. Radioiodine uptake tests were made before treatment was commenced, and was repeated at intervals, sometimes several years after the first test. It became apparent from the results that radiotherapy could alter the uptake, even when care was taken to shield the thyroid. The mean values for the thyroid uptakes in the lymphoma and control patients were 24.81 and 33.91%. The difference was significant at the 0.1% level. The effect of radiotherapy to sites other than the abdomen was studied in 25 patients. The mean uptakes for the first and last tests were 27.4 and 21%, the difference being significant at the 2% level. The thyroid glands of patients receiving radiotherapy to the neck or mediastinum were shielded, but the effect of small doses of scattered radiation could not be excluded. Eleven patients were tested before and after radiotherapy to the abdomen. The mean uptakes before and after were 18.7 and 29.5%, respectively. It is suggested that lymphoma tissue may, by decreasing thyrotropin (TSH) levels, cause a depression of the uptake tests. The elimination by irradiation of TSH-inactivating substances in the liver, spleen, and retroabdominal lymph nodes may be the explanation of the elevation in the uptake test following radiotherapy to the abdomen. (BBB)

16508 LATE FISTULA AFTER IRRADIATION OF CERVICAL CANCER. Halter, G. (Allgemeines Krankenhaus der Stadt, Linz, Ger.). Wien. Med. Wochschr., 115: 510(June 19, 1965). (In German).

The frequency of bladder fistula after irradiation treatment of cervical carcinoma has been reported to be from 1.3 to 2.2%. Usually there is a latent period of several years, sometimes with an accompanying ulcerous cystitis, before appearance of the fistula. A case is reported in which bladder fistula appeared in an 82-yr-old patient who had received irradiation treatment for a stage II cervical carcinoma 37 years previously. The treatment had consisted of three mesothorium implants and a single implantation of the tumor with needles. The tumor was a squamous cell carcinoma. The tissue in the region of the fistula was necrotized and the vascular network was somewhat arteriosclerosed. The extreme age of the patient suggested that these symptoms may have contributed generally to the appearance of the fistula so many years after the irradiation treatment. Direct surgical repair of the fistula was not possible, and ureteral implantation in the sigmoid was initiated. (BBB)

16509 RADIATION EFFECTS AND ADRENAL CORTEX. II. QUALITATIVE AND QUANTITATIVE ESTIMATIONS OF ADRENAL CORTICOIDS IN WHOLE-BODY IRRADIATED RATS. Muenip Yegin, M. (Cekmece Nuklear Arastirma, Istanbul). Endokrinologie, 49: 205-23(1966). (In German).

Albino rats of both sexes, with average wt of 155 g, were irradiated with 200-kv x ray in a single whole-body dose of 1000 R. The dose rate amounted to 90 R/min. The animals were killed 4 days after irradiation and the adrenal corticoids measured by thin layer chromatography, paper chromatography, and colorimetrically. The corticoids measured included deoxycorticosterone, Reichstein's substance S, corticosterone, 11-dehydrocorticosterone, hydrocortisone, cortisone, aldosterone, and an unknown steroid. Corticosterone and total corticoids were increased significantly in the irradiated animals, both on an absolute basis and as a fraction of the control values. The author describes details of the analytical methods used. (BBB)

16510 KARYOMETRIC STUDIES IN GRAFTED TUMORS IRRADIATED WITH 180 keV X-RAYS AND WITH 30 MeV FAST ELECTRONS. I. OSCILLATIONS INDUCED IN TYPE I CELLS. Paolini, F. A. (Univ., Zurigo, Italy. Univ., Pavia, Italy). Radiol. Med., 52: 588-604(June 1966). (In Italian).

The author presents studies performed on the solid variant of Ehrlich's tumor irradiated with both 180 keV X-rays and 30 MeV fast electrons. Karyometric study of the nucleolus, nucleus and cytoplasm of type I cells, distinguished from the others by application of Schairer's ratio and of Homann–Reiche's morphological standard, has supplied useful results for the subsequent statistical analysis performed according to the linear regression method. Comparative examination of the regression itself leads to the following observations. Both types of radiations used cause, even at low doses, disappearance of the geometrical doubling progression of the more frequent volumetric classes, of the type usually detectable for normal cells. With both the radiations used the volumetric quotients of the cell parts examined and the corresponding percentage frequencies progressively increase on raising the doses. As indicated by the ratio between the regression coefficients the intensity of the induced effect differs, at equivalent doses, in the case of X-rays from that produced by fast electrons: applying the hypothesis of a lethal critical volume constant for both the radiations considered, it is possible to calculate the D_β as a function of the D_{Rx}. The ratio between the regression coefficients also indicates the variability of the ratio Rx/β in relation to the parts of the cell considered, whether nucleolus, nucleus, or cytoplasm. (auth)

16511 A COHORT-TYPE STUDY OF SURVIVAL IN THE CHILDREN OF PARENTS EXPOSED TO ATOMIC BOMBINGS.

Kato, Hiroo (Atomic Bomb Casualty Commission, Hiroshima); Schull, William J.; Neel, James V. Amer. J. Human Genet., 18: 339-73(July 1966). (TID-22853).

Children born subsequent to the atomic bombings of Hiroshima and Nagasaki were divided into 3 groups on the basis of parental exposure: heavily exposed, lightly exposed one, and nonexposed. This cohort-type study failed to disclose significant variation in mortality ascribable to differences in irradiation. Failure to demonstrate significant differences among the exposure groups does not necessarily imply that there are no differences, but merely means that within these years and observations no effect is seen. These data, considered in conjunction with the other data from Hiroshima and Nagasaki are used to approximate the minimal doubling dose for man, i.e., the amount of radiation necessary to produce the same number of mutations as occur spontaneously each generation. The value is probably not less than 50 R for radiation of the type emitted by an atomic bomb and for mutations of the type resulting in early death in the first post-bomb generation. It is further suggested that under the more usual conditions of human exposure to radiation, the doubling dose for mutations of this type is about 100 R. (BBB)

16512 UNDERDEVELOPMENT OF THE HUMAN BREAST AFTER RADIOTHERAPY. Weidman, Abraham I.; Zimany, Alexander; Kopf, Alfred W. (New York Univ., N. Y.). Arch. Dermatol., 93: 708-10(June 1966).

Two patients are reported who were treated with radium for cutaneous hemangiomas at an early age and suffered subsequent failure of proper development of breasts. During the first 4 yr of life, the first patient was treated with 13 applications of radium needles, set in different configurations to at least 3 different sites on the breast. At 18 years of age, the patient sought medical attention because of a poorly developed right breast associated with mild tenderness and pain, most marked during menses. In case 2, during the first year of life, the patient received 3 radium treatments of unknown quantity for a hemangioma of the right breast. The hemangioma gradually disappeared, but at 13 yr of age, asymmetry of her developing breasts was noted, the right having remained considerably smaller than the left. From a review of earlier reports and experience with the 2 cases herein reported, the min dose of radiation which leads to arrest in human breast development can not be ascertained. However, it is likely that the least amount of radiation which will affect a hemangioma favorably or a more serious condition in the region of breast, will interfere with proper maturation of mammae. Since hemangiomata have a strong tendency toward spontaneous involution, it is best not to irradiate them when they are located around the mammary area. (TCO)

16513 DECREASED VARIABILITY IN THE CESTODE HYMENOLEPIS DIMINUTA FOLLOWING IRRADIATION OF SUCCESSIVE GENERATIONS. Job, P. S.; Jones, A. W.; Dvorak, J. A.; Kisner, R. L. (Univ. of Tennessee, Knoxville). Evolution, 17: 163-9(June 1963).

When cestodes received very large doses of ionizing radiation over several generations, the amount of morphological variation expected to result from this treatment did not occur; in fact, the cestode progeny became more uniform than their parents. For irradiation of cysticercoids for the experimental stocks, infected Tribolium larvae were transferred to a small plastic vial and were exposed to 15,000 R of γ radiation at the rate of 450-500 R/min. Within 5 hr after irradiation mature cysticercoids were removed from these flour beetle larvae and were fed to male rats 4 to 5 months old. Fecal pellets from these infected rats were collected within a month after infection and the whole process of irradiation and infection was repeated for 8 generations, thereby building up the cumulative dose of radiation to 120,000 R. Groups receiving no radiation and 60,000 R were also used. Number and size (area) of proglottids, anomalies of proglottid-formation, and abnormalities of reproductive organs were observed in the 3 groups over 8 generations. When progeny of each generation were analyzed for such morphological variations, compared with unirradiated worms, the irradiated worms were relatively uniform. They differed from the normal in size of gravid proglottids, rate of growth, and disposition of testes. Infectivity of cysticercoid larvae was not reduced by radiation. These results were unexpected, since others had reported variation increasing with dose. Selection, genetic drift, and inbreeding are suggested as interacting factors which may have overcome the expected effect of the treatment. Inbreeding seems theoretically capable of reducing somewhat in one generation the heterozygosity repeatedly introduced by irradiation, and may thus account for the presumably non-adaptive change (decrease in anomalies) that took place in the direction of phenotypic uniformity. (BBB)

16514 COMPARISON OF THE IMMUNOGENIC EFFICIENCIES OF NORMAL AND X-IRRADIATED ANCYLOSTOMA CANINUM LARVAE IN DOGS. Miller, T. A. (Univ. Coll., Nairobi, Kenya). J. Parasitol., 52: 512-19(June 1966).

Radiation can be used as an agent of attenuation for the preparation of a vaccine against A. caninum infection of dogs. This vaccine is successful in protecting dogs of various ages against the establishment of a challenge inoculation of normal hookworms, and against the potential pathogenicity and lethality of the challenge infection. The resistance induced by vaccination with x-irradiated larvae was compared with the resistance stimulated by similar doses of normal infective larvae. Experiments were conducted in previously uninfected dogs aged 3 to 6 months to evaluate the immunogenic efficiencies of a double vaccination schedule with 1000 normal and with 1000 40-kR irradiated larvae. Subcutaneous vaccination with 40-kR irradiated larvae stimulated a more uniform and higher level of immunity than did oral vaccination, when the resistance was measured by hookworm establishment from the challenge inoculation. Subcutaneous vaccination with irradiated larvae was also more effective than vaccination with normal infective larvae by either oral or subcutaneous administration. Attempted vaccination with normal infective larvae was an extremely hazardous procedure for health and survival of the dog. The arrest of radiation-damaged larvae in some migratory somatic location in the tissues of the dog was presumably responsible for optimum immunogenesis. (BBB)

16515 EFFECTS OF LASER RADIATION ON THE MAMMALIAN EYE. Ham, W. T. Jr.; Williams, R. C.; Mueller, H. A.; Guerry III, DuPont; Clarke, A. M.; Geeraets, W. J. (Medical Coll., Richmond, Va.). Trans. N. Y. Acad. Sci., 28: 517-26(Feb. 1966).

The biological effects of laser radiation were investigated in terms of thermal injury for retinal irradiances below the threshold for nonlinear effects and for exposure times of sufficient duration to allow the application of the classical laws of heat conduction. Since most laser pulses rarely exceed 1 to 2 msec, only the pigment epithelium (PE) is involved in mild lesions. A schematic diagram illustrates the ratio of image dia to thickness for exposure times less than 1 msec and greater than 10 msec. Longer exposures (>20 msec) cause a marked spread of biological damage beyond the confines of the original image. For exposure times greater than 10 msec there is time for heat flow from the choroid to have effects on the PE. Histological evidence confirms the involvement of the choroid as well as the PE for mild lesions produced by long exposure times. For long exposure times, heat loss from blood flow increases the irradiance necessary to create a mild lesion in the rabbit retina. However, for small image sizes and short exposure times, such as those likely to be encountered on exposure to pulsed laser beams, the effect of blood flow is negligible. Calculations were made of temperature in the PE by solving the differential equation for heat flow in the steady state. The thermal concept of retinal injury is inadequate to explain the biological effects induced in the eye by the high power densities (MW/cm^2) and short exposure times (5 to 50 nsec) produced by large laser pulses resulting from Q-switching. The pigment granules or absorbing sites in the PE would reach high temperatures during the early stages of a large pulse, producing ionization and possibly a plasma which would be opaque to additional incoming photons. Other processes, including two-quanta excitation, Raman and Brillouin scattering, shock waves, frequency doubling, and reradiation by black body emission must be considered as possible means for dissipating energy before heat conduction has time to play a prominent role. (BBB)

16516 BIOELECTRIC POTENTIALS IN SKIN BURNS AND X-RAY ERYTHEMAS. Johnston, Lloyd Waldon. Nashville, Vanderbilt Univ., 1966. 91p.

Thesis.

The objective of the present investigation was to measure the changes in electric potential in thermal burns and x-ray injuries on the skin of rats, relative to nonirritated skin surfaces. The injured areas were circular and of 1.3 centimeter diameter. The burns were produced at temperatures 180°C, 220°C, and 260°C, and the radiation injuries with x-ray exposure doses of 17,400 and 26,100 R. The electric potentials were measured with the vibrating probe electrometer. A vibrating metal probe, somewhat smaller in size than the wound area, was brought close to the surface to be studied. Electric potential variations generated in the probe by the presence of an electric surface charge were amplified and displayed on the screen of an oscilloscope. In order to get a measure of the potential, the skin surface potential was compensated, in principle, with the help of a potentiometer until the signal on the oscilloscope screen was zero. It was found that the acute inflammation produced on skin-surfaces of rats by burns and x rays is accompanied by the generation of a negative injury potential of the order of -60 millivolts, relative to the healthy skin surface. The potential changes become observable after one day for heavy burns,

and after four days for milder burns. For x irradiation, the latent period of about four days coincided with the appearance of skin erythema. In spite of the much larger absorbed energy in the case of the thermal wounds than in x-ray wounds, the burned skin recovered within a period of 20 days, whereas the x-ray injuries did not heal within the same length of time. Considering the general physiological and biochemical changes in skin wounds, the build-up of the negative potential on the site of thermal injury may be attributed to an increase of capillary permeability to plasma proteins, and actual damage to capillaries and dermal tissues, resulting in protein release and accumulation of negatively charged protein molecules in the wound surface. In the case of extended latent periods before the development of wound potentials (as with x rays), such as the effect on the capillaries, were produced through delayed action mechanisms of endogenous vasoactive substances. Influences of dimethyl-sulfoxide (DMSO) and negative airion bombardment on the injury potentials have been studied in an exploratory manner. The application of the vibrating probe electrometer to the measurement of skin surface potentials avoided an increase in irritation otherwise caused by contact electrodes. The instrument did not allow the observation at deeper layers of the dermis. Used as a diagnostic instrument, the vibrating probe electrometer did not give evidence of skin damage (burns or radiation injuries) that could not have been found from visual inspection at the site of irritation, but the instrument recommended itself for the objective characterization of wound conditions and various stages of wound healing. (Dissertation Abstr.)

Radiation Effects on Plants

Refer also to abstracts 16312, 16429, 16450, and 16558.

16517 (JPRS–38272, pp 7–8) THE SENSITIVITY OF POTATO SEEDS TO PROTON AND GAMMA RADIATION. Abramova, V. M.; Gertsuskii, D. F.; Alekseenko, L. V.; Nevzgodina, L. V.; Popkova, S. A. Translated from pp 9–10 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Potato seeds were exposed to 660-MeV protons and to γ radiation in the dose range of 500 to 50,000 rad. Irradiation of seeds caused considerable changes in the growth and development of seedlings, with protons having the greater effect. The 100% lethal dose for seeds exposed to protons was about 30,000 rad and the 100% lethal dose for γ radiation was in excess of 50,000 rad. Radiation doses of 500 to 10,000 rad stimulated tuber formation while doses greater than 10,000 rad suppressed tuber formation. The values of the coefficients of relative biological effectiveness of γ and protons ranged from 0.5 to 2.3. A study of the effects of γ and protons on chromosomes showed that the coefficient of relative genetic effectiveness, based on the percentage of cells with chromosome aberrations, in the 500 to 50,000 rad dose range varied from 0.7 to 2.6. It was concluded that there was good agreement between the values for relative biological and genetic effectiveness of protons with an energy of 600 MeV for potato seeds. It was shown that it was possible to obtain marketable potatoes during the first year of cultivation of plants grown from seeds. It is suggested that during prolonged space flights the growing of potatoes from seeds could have practical importance. (C.H.)

16518 (JPRS–38272, pp 148–9) THE EFFECT OF PROTONS OF 660 MeV AND GAMMA RAYS ON POTATOES UPON PRE-PLANTING IRRADIATION OF THE TUBERS. Gertsuskii, D. F.; Abramova, V. M.; Alekseenko, L. V.; Sychkov, M. A.; Popkova, S. A.; Petrenko, L. M. Translated from pp 119–20 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Results are reported from a study of the growth and development of potato plants grown from tubers exposed to 660-MeV protons or ^{60}Co γ radiation at doses ranging from 250 to 1000 rad. The criteria for evaluation were germination, rate of development, and number and yield of tubers. Visual observations of the plants indicated a stimulating effect of small doses (250 to 500 rad) of radiation during early development that disappeared gradually with time. Radiation doses of 4000 rad of both protons and γ radiation resulted in the complete absence of germination of the tubers during the vegetation period. The yield of potatoes was reduced as the radiation dose was increased. Protons had a greater effect on the growth, development, and yield of potatoes than did γ radiation. (C.H.)

16519 (JPRS–38272, pp 371) THE EFFECT OF IONIZING RADIATION ON THE CHROMOSOME APPARATUS OF HIGHER PLANTS. Nevzgodina, L. V.; Grigor'yan, N. M. Translated from pp 286 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

The relative biological effectiveness of 660-MeV protons was compared with that of γ rays using chromosome aberrations induced in plants of cabbage, carrots, and potatoes grown from exposed seeds as the criteria. No differences in the effects of small doses of protons or γ radiation were observed but at doses of 5 to 250 kR protons caused a greater effect than γ. The relative genetic effectiveness of protons as compared to γ increased with dose from 0.7 to 2.6 for potatoes, from 1 to 3.6 for cabbage, and from 1 to 11 for carrots. (C.H.)

16520 CHANGES IN SOME QUANTITATIVE CHARACTERS ON BARLEY AFTER CHRONIC IRRADIATION. Honcariv, R.; Kovac, L.; Danko, V. (Univ., Kosice, Czech. Selection Station, Maly Saris, Czech.). pp 99–101 of Mutation in Population. Honcariv, Robert (ed.). Prague, Czechoslovak Academy of Sciences, 1966.

A summary of results from a four-year study of the effects of chronic irradiation on the quantitative character of barley is presented. Plants were irradiated during the entire vegetative cycle until seed maturation. Dose rates were 0.262, 1.043, 4.100, and 16.800 R/day from a 75-C ^{60}Co source. Plants grown at the protected border of the "gamma-field" were used as controls. Further generations were cultivated in the absence of radiation. Analysis of seed numbers and plant heights revealed statistically significant effects in the second generation of plants originally irradiated with doses in excess of 1 R/day. These effects did not persist into the third or fourth generation. Fertility and mutation rates were affected by smaller doses. (M.M.B.)

16521 GENETIC AND BREEDING INVESTIGATIONS IN TAGETES. II. THE PRODUCTION, GENETICS, AND USE OF X-RAY INDUCED MUTANTS IN BREEDING. Bolz, G. Z. Pflanzenzuecht., 45: 121-42(1961). (In German).

Mutants of the ornamental flower were produced as a result of x-irradiating presoaked seeds of the following varieties: Tagetes erecta Mann im Mond, T. patula Goldzwerg, and T. patula Rostrot. The doses employed (5500, 9000, 12,000, and 20,000 R) did not cause a reduction in germination. However, the 20,000-R dose caused an almost complete inhibition of further growth beyond the cotyledon stage. The range between 9000 and 12,000 R was especially favorable for producing mutants in the variety Mann im Mond of T. erecta. The use of the pure female mutant fermina for the production of F_1 varieties in T. erecta is discussed. The possible importance of two mutants for practical horticulture, namely the ivory-colored mutant eburnea and the dwarf habit mutant nana, was also discussed. (BBB)

16522 CYTOGENETICAL EFFECTS OF X RAYS, THERMAL NEUTRONS, AND β PARTICLES ON ORYZA SATIVA L. Shastry, S. V. S.; Ramaiah, K. (Indian Agricultural Research Inst., New Delhi). Indian J. Genet. Plant Breed., 21: 43-51(Mar. 1961).

Dry and soaked dehusked rice seeds were subjected to x or neutron radiation or placed in solutions of $H_2{}^{35}SO_4$ for β irradiation. Germination was completely unaffected even at the highest dose of x rays (44 kR to soaked seeds) employed, while it was reduced by 12% at the highest dose (9 μC per seed) of ^{35}S treatment. Germination was significantly quicker with all the doses of thermal neutron irradiation used. While the controls exhibited germination of only 36% of seeds at 24 hr, at an integral flux of 3.29×10^{12} of thermal neutrons, 90% of the seeds germinated by this time. Lethality of the seedlings following irradiation was pronounced with x ray and ^{35}S treatments while negligible with thermal neutrons. The LD_{50} for the soaked series was below 11 kR, while for dry seed it was between 22 and 33 kR. Three, 6, and 9 μC of ^{35}S/seed were lethal to 29, 60, and 75% of the seedlings. Lethality following irradiation with thermal neutrons was negligible and comparable to that in the control series. Irradiation with x or β rays but not neutrons markedly reduced the height of the seedlings. Following x ray and thermal neutron irradiation, five chlorophyll mutant plants were noted. Cytologic analysis showed that multivalents were the most frequent abnormality in the M_1 generation, the highest association observed being a hexavalent. These were most frequent in x-irradiated material, followed by neutron and isotope-treated ones. The chimeric nature of M_1 plants and its significance for the yield of chromosomal aberrations in M_1 generation and the recovery of mutations in M_2 generation are discussed. Data on chlorophyll mutation indicated that xantha mutations were more frequently encountered following treatment with ^{35}S, while albinas were more frequent following x irradiation. (BBB)

16523 THE GATERSLEBEN MUTANTS OF CULTIVATED BARLEY IN RELATION TO THE MULTIPLICITY OF FORMS OF THE SPECIES HORDEUM VULGARE L. s. l. IV. Scholz, Friedrich; Lehmann, Christian O. (Institut fuer Kulturpflanzenforschung, Gatersleben, Ger.). Kulturpflanze, 10: 312-34(1962). (In German).

The taxonomic and genetic relation between x-ray-induced mutants and the natural forms of barley (Hordeum vulgare L.s.l.) were studied in the Gatersleben collection of radioinduced mutant

lines. Morphological descriptions of 171 mutant lines of 2-rowed spring barley and 6-rowed winter barley were used as the basis for the study. These lines were grouped according to main characters and incorporated into the morphological system of barley. The 900 mutant lines of the collection were classified in the same way. In general, the mutant lines could be arranged into the system without difficulty, providing that classification of the monster characters was neglected since these are of no importance to the evolution of cultivated barley. Lines in which the mutant character was not used in the present system of classification were placed under the same variety (varietas) as the original. Lines in which the mutant character was used in the system of classification were placed under another variety and not the original. The new combinations of characters, that is of the varieties which originated by mutation, could also have arisen by recombination of genes, by crosses between well-known forms. In principle, there was a genetic correspondence between the x-ray-induced mutants and well-known forms of the world collection. According to these studies and those of other authors, in several cases morphologically corresponding forms were found to be genetically identical or allelic. In general, most of the characters which originated by x-ray-induced mutation are already known from the present diversity of forms, inasmuch as they have no distinctly negative selection value. By experimental induction of mutation only, such forms can be produced which have already been created or which are capable of developing by evolution. Some related problems of evolution and mutation breeding are discussed. (BBB)

16524 THE GATERSLEBEN MUTANTS OF CULTIVATED BARLEY IN RELATION TO THE MULTIPLICITY OF FORMS OF THE SPECIES HORDEUM VULGARE L. s. l. III. Scholz, Friedrich; Lehmann, Christian O. (Institut fuer Kulturpflanzenforschung, Gatersleben, Ger.). Kulturpflanze, 9: 230-72(1961). (In German).

Morphological descriptions and illustrations are given of 18 x-ray-induced mutants of several 6-rowed winter barley varieties (cultivars) as well as of 29 x-ray-induced mutants of several 2-rowed spring barley varieties. The mutants are of the taxonomical rank line which is at the same level as cultivar (variety); grouped according to characters, they are integrated into the morphological system of cultivated barley. Forty-six of these mutant lines are placed in 14 different varieties (varietates) of the convarieties (convarietates) hexastichon Alef s.l. and distichon Alef. Two of these varieties (var. curtoaristatum and var. decurtatum) represent new combinations of characters and are described in detail. For one mutant, integration was not possible because it does not form ears and can be propagated only by heterozygotes. Crossing experiment results are given that show that as a rule the main characters of the mutants are conditioned by single recessive genes. (BBB)

16525 MODIFICATIONS OF PLANT GROWTH AND DEVELOPMENT INDUCED BY IONIZING RADIATIONS. Gunckel, J. E. (Rutgers Univ., New Brunswick, N. J.). pp 365-87 of Encyclopedia of Plant Physiology. Vol. 15. Ruhland, W. (ed.). Berlin, Springer-Verlag, 1961.

In this review, radiation-induced morphogenetic responses are analyzed or explained in terms of genetic, cytological, and physiological factors. Where applicable, various physiological explanations are offered to account for particular responses in growth and development. It is shown that radiation effects on the physiology of cells may be influenced by available oxygen, the presence of protective materials, the amount of water in the cells, and metabolites, enzyme inhibitors, pH, and temperature. Studies of respiration and aerobic glycolysis have generally not provided evidence of direct interference by radiation with the activity of the enzymes concerned at dose levels below about 10,000 to 30,000 R, although neutrons in a lower range (300 to 3600 rep) were effective in reducing both growth and respiration of barley seedlings. It has been suggested that substrates of intermediate enzymes are limiting, particularly in the case of pacemaker reactions. It has been found that 1000 R doses of x radiation upset the metabolism of phosphorus-containing compounds in the roots of wheat. High-molecular compounds, such as nucleoproteins and lipoproteins, showed a decreased rate of synthesis whereas low-molecular compounds, such as phosphoric esters of carbohydrates and free phosphatides, showed an increased rate of synthesis. Several studies have demonstrated the relatively high sensitivity of DNA synthesis to radiation (in the range of 100 to 1000 R). Another enzyme system, that involved the conversion of tryptophan to indoleacetic acid has been shown to be very radiosensitive (in the range of 25 to 1000 R). Thus, in vitro studies have indicated the chemical links and groups which may be most easily altered by ionizing radiation. Attempts to apply in vitro findings to intact cells have been disappointing. (BBB)

16526 INTERFERENCE BY THE MINERAL NUTRITION AND BY THE RADIATION EMITTED FROM ^{32}P ON THE GROWTH OF THE COTTON PLANT. Dejaegere, R. (Univ. Libre, Brussels). Mededel. Landbouwhogeschool Opzoekingssta. Staat Ghent, 30: No. 2, 1105-12(1965). (In French).

Studies were conducted for 54 days on the effects in cotton plants of the mineral composition of the nutrient medium and on the radiobiological effects of ^{32}P. Nine treatments of a combination of 3 mineral solutions (differing from one another by their proportions of nitrate, sulfate, and phosphate) with three doses of ^{32}P (0, 20, and 60 μC in each pot) were given. Neither the growth nor the mass of elaborated vegetable material seemed to be affected by the presence of ^{32}P. When ^{32}P was added at levels of 20 and 60 μC per pot, the mean P content of the leaves was decreased 17 and 19% with nitrate and sulfate addition, but only 5% with phosphate addition. (TSS)

16527 INTERACTION OF SHORT WAVE AND LONG WAVE RADIATION IN THE PHOTOMORPHOGENESIS OF PISUM AND SINAPIS. Haupt, Wolfgang; Kraml, Manfred (Univ., Erlangen, Ger.). Naturwissenschaften, 53: 616(1966). (In German).

In the phytochrome-induced growth inhibition of the internodes and the surface growth of leaves of Pisum, bright red can be produced to a certain extent by uv or blue but also a dark red effect of the uv or blue is detectable. A stabilization of the bright red induction by uv or blue was not detectable in Pisum. For the corresponding light effect on hypocotyl and cotyledons, of Sinapis, bright red can be produced by short wave radiation only very slightly and an induction release in the direction of a dark red effect is not possible by uv or blue. (J.S.R.)

16528 EFFECT OF GROWTH INHIBITORS AND X RAYS ON THE GROWTH OF PEA ROOTS. Brucker, W. (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe, 15: 41-52(1966). (In German).

Sprouting roots of Pisum sativum were x irradiated with 100 or 400 R at a rate of 125 R/min and the effects of cytostatics, antibiotics, antivitamins, and substances with growth-promoting effects were studied. Pretreatment of the roots with the cytostatic Mitomen at 5×10^{-5} and 10^{-4} g/ml, thio-TEPA, Trenimon, and Tetramin at the same final concentrations, and final irradiation with 100 R increased the radiogenic growth depression by a maximum of 400%. Under the same conditions TEM (triethylenemelamine) reduced radiation injury. None of the cytostatics tested had any effects when 400 R were used. Pretreatment of the roots with mitomycin C reduced radiation injury from the 400 R. The combination of mitomycin C and 100 R increased growth requirements. Actinomycin C_3 and aureomycin had similar effects. Sarcomycin A and chloramphenicol increased the growth-reducing effect of 100 R. However, with 400 R they demonstrated a radioprotective effect. Triiodothyronine and vitamin K_1 increased the growth of young roots. After irradiation with 100 R, but not with 400 R, triiodothyronine at a concentration of 5×10^{-5} g/ml produced complete radioprotection. Vitamin K_1 increased radiation injuries by 100% at 100 R, and had a sensitizing effect at 400 R. No significant effects were shown by β-indolylbutyric acid and Kinetin. Pretreatment with antivitamins such as aminopterin and deoxypyridoxine increased radiation injury caused by 100 R. These substances had little effect on the growth depression caused by 400-R irradiation. References cited, 97. (BBB)

16529 ON THE PHOSPHATE METABOLISM OF X-IRRADIATED TOMATO PLANTS. Brucker, Wolfgang (Ernst-Moritz-Arndt-Univ., Greifswald, Ger.). Flora (Jena), Abt. A, 156: 197-206(1965). (In German).

Crown gall tumors were induced in plants of Solanum lycopersicum 25 to 30 cm long by infection with Agrobacterium tumefaciens. After 4 weeks' development a 10-cm long section of the stems were x irradiated with 20 KR at a dose rate of 1 KR/min. The P content in various components of the plants was measured at various times during a 14-day interval after irradiation. Results are reported. (TSS)

16530 UV PATTERNING IN BLOSSOMS AND ITS OCCURRENCE. Kugler, H. Planta, 59: 296-329(1963). (In German).

Patterning in blossoms is increased by exposure to uv radiation. However, no new types of patterns appear in the short-wave range, but streak and mottling stigmata occur frequently. On the other hand, speckled stigmata do not seem to appear. Patterning of uv-free stigmata is less frequent in radial blossoms than in dorsiventral blossoms. The proportion of pure uv-free stigmata is greater in the radial forms than in the dorsiventral. With the uv-free stigmata there is a relation to the blossom form, because they are adjacent to the mouth of the blossom or

to the nectary. In the dorsiventral forms they can also appear at the tips of the petals, or at the rib or lobe in papilionaceous plants. There is a difference between brilliancy and diffuse reflection when uv radiation is reflected. Brilliancy occurs at the outer wall of the epidermis, while diffuse reflection takes place usually at the deeper layers of tissue, internal bodies, and particularly at the surfaces of the boundary between cell membrane and the intercellular air. This is known as the tapetum effect. As a result of this tapetum effect a normal leaf reflects uv light like visible light more intensely at the intercostal fields than at the veins. However, the differences are only quantitative, and there are no qualitative differences, such as, for example, a color differentiation. The uv-free stimata depend on the presence of tissue substances that absorb uv radiation. These substances could be visible pigments or invisible pigments that react with $FeCl_2$. After extraction of these substances with ethanol or isopropanol the leaves reflect uv well and no longer exhibit any pattern. This is true for Ranunculus acer whose tapetum intensity is not involved with formation of uv stigmata or where some other tapetum effect takes place. (BBB)

16531 EFFECT OF UV LIGHT ON LETTUCE SEED GERMINATION AND ON THE UNFOLDING OF GRASS LEAVES. Wagne, Claes (Univ. of Gothenburg, Sweden). Physiol. Plant., 19: 128-33(1966).

The effect of uv light on germination of lettuce (Lactuca sativa) seeds and on the unfolding of wheat (Triticum vulgare) leaves was studied. A small improvement in germination was noted on exposure to light of 254, 265, 334, and 405 nm, and in unfolding on exposure to light of 254, 265, 313, 334, 365, and 405 nm. The low germination rate at 238 nm shows that light energy absorbed by the high-absorbing protein part of the phytochrome cannot be used in the germination process. It is evident that irradiation at some wavelengths of uv has a slight effect on seed germination and on the unfolding of etiolated leaves, but the effect of the uv irradiation is lower than that of red light. The unfolding of wheat leaves shows maxima at 405 and 313 nm. Irradiation at 313 nm, on the other hand, inhibits germination. This difference in the effect of irradiation might be explained by the presence of screening pigments, which is more abundant in the seeds than in the leaves. The inhibiting effect of 238-nm exposure is not as marked on the unfolding of lettuce as on wheat. This might be explained by the fact that an inhibitory effect of light on leaf unfolding cannot be distinguished from indifference, while an inhibition of seed germination is always readily recognized. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 16072, 16299, 16315, 16402, 16429, and 16558.

16532 (JPRS-38272, pp 77-8) THE EFFECT OF GAMMA RADIATION AND PROTONS WITH ENERGIES OF 127-660 MeV ON THE RADIATION INJURY OF YEAST CELLS. Benevolinskii, V. N.; Druzhinin, Yu. P.; Klimenko, A. S.; Malyutina, T. S.; Sychkov, I. A. Translated from pp 63-4 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Results are summarized from a study on the relative biological effectiveness of protons with energies of 660, 510, 240, and 127 MeV and ^{60}Co γ radiation on cell division of a diploid strain of yeast (Saccharomyces vini) and a haploid strain (Saccharomyces cerevisiae). The dose rates ranged from 1 to 120 rad. The disruption of the rate of division during the first 5 cycles after irradiation and the formation of macrocolonies or various forms of microcolonies after irradiation were used as the index of radiation effects. The effects of protons did not differ significantly from the effects of γ radiation. (C.H.)

16533 (JPRS-38272, pp 120-1) THE INFLUENCE OF PROTON AND GAMMA RADIATION ON THE MITOTIC ACTIVITY OF AN INOCULATED CULTURE OF HUMAN CELLS. Vasil'ev, I. S.; Ryzhov, N. I.; Derbeneva, N. N.; Portman, A. I.; Dorofeeva, N. Zh.; Khlaponina, V. F.; Kabachenko, A. S. Translated from pp 97-8 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24-27, 1966.

Results are summarized from a study on the relative biological effectiveness of 630-MeV protons and ^{60}Co γ radiation for inducing changes in mitotic activity in cultured human amniotic cells. The radiation doses ranged from 40 to 1500 rad. The mitotic index was determined directly after irradiation and at various times up to 60 hr post-irradiation. A distinct relation between radiation dose and the suppression of mitotic activity was observed. Restoration of mitotic activity was noted at 36 to 40 hr after exposure to all doses of both protons and γ radiation. At 24 hr post-irradiation the mitotic index of cells exposed to γ radiation differed with that of cells exposed to protons. (C.H.)

16534 UV-INDUCED BIOCHEMICAL MUTATION IN ASPERGILLUS CHEVALIERI. Nanda, Geeta; Nandi, P. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 32: 257-9(May 1966).

The survival and mutation rates of uv-irradiated spore suspensions of A. chevalieri (73070) are reported and morphological and biochemical mutants thus derived are characterized. A germicidal lamp emitting 90% of its radiant energy at 2537 Å was used at dose rates of 50, 100, and 150 erg/mm² sec. After irradiation, the spore suspension was diluted with normal saline and plated out in complete medium (CM). Individual colonies appearing on CM agar plates were transferred to minimal agar medium (MM). The highest percentage of mutation was recorded after 240-sec exposure with an incident uv dose rate of 150 erg/mm²/sec. With increase in the time of exposure, survival percentage fell rapidly while mutation percentage declined gradually after rising to a peak. The results are in agreement with previous reports on other Aspergillus species. The total number of isolates tested was 194, of which 82 were biochemical and 112 morphological mutants. The morphological mutants were characterized as having altered colonial morphology, texture of mycelial growth, rate of growth on agar medium, and pigmentation of the conidial heads. In screening of biochemical mutants, the failure of growth of all colonies on MM agar was considered to be the criterion of nutritional deficiency which was further characterized according to requirement for essential metabolites. The strains responding to one or more nutrients for growth in the auxanographic test were grouped as deficient mutants requiring vitamins, amino acids, and nucleic acids. Of the biochemical mutants, 44 required amino acid, 25 vitamins, 10 nucleic acids, and 3 unknown factors. (BBB)

16535 EVALUATION OF DNA CONTENT IN SERRATIA PHAGE KAPPA BECAUSE OF ITS X-RAY SENSITIVITY. Winkler, Ulrich (Univ., Frankfurt am Main). Z. Allgem. Mikrobiol., 6: 271-4(1966). (In German).

The phages kappa and lambda were x irradiated together in bouillon suspension and titrated against mutants of Escherichia coli K_{12} or Serratia marcescens HY. The suspension was irradiated with 55-kv x rays for intervals of up to over 30 min. These hcr⁻ mutants were used because wild cell types are partially able to reactivate x-ray-induced lethal injuries in the DNA of phages and thus mask the radiosensitivity of the phages. The survival curve of kappa phage had almost the same inactivation constants as those of the lambda phage (0.279 or 0.291/min). Thus the same quantity of DNA, or about 0.77×10^{-16} g/plaque-forming unit, can be assumed. In the same way the phages T4r102 and kappa were irradiated together and titrated against hcr mutants. The chances of survival of phage T4 is independent of the reactivation capacity of the indicator cells. In 2 different studies the inactivation constant of the survival curve of the T4r102 was 2.75, or 2.61 times greater than the survival curve of kappa. The amount of DNA in T4r102 amounts to 1.98×10^{-16} g/plaque forming unit. This gives a value for kappa DNA of 0.72 to 0.76×10^{-16} g/plaque forming unit. The amount of DNA is calculated from the slope of the survival curve, which takes into account the plaque forming capacity exclusively. (BBB)

16536 GENETICALLY CONTROLLED PHOTOREACTIVATION OF AN ULTRAVIOLET-INDUCED EXTRACHROMOSOMAL MUTATION IN YEAST. Pittman, David; Loker, Lowell (Southern Illinois Univ., Carbondale). pp 299-304 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

Various data were cited in support of the hypothesis that photoreactivation (PR) mechanisms are under genetic control. Photoreactivation of an extra-chromosomal mutation in yeast, in which photoreversal of the mutational process was shown to be under control of a single gene-pair showing simple dominance for the photoreactivable trait is discussed. When normal (r+ y+) and genic (r y+) yeast stocks were irradiated with intermediate uv radiation doses, a large proportion of the survivors formed colonies that carried the extrachromosomal defect r+ y and r y, respectively. However, only the mutation in normal stocks was photoreactivable. The mutation was also photoreactivable in homozygous dominant (r+/r+) and heterozygous (r+/r) diploids but nonphotoreactivable in the homozygous recessive (r/r) stock. The heterozygote on sporulation produced two normal (r+ y+) and two genic (r y+) segregants; the mutation was photoreactivated in the former two segregants, but not in the latter two. Ultraviolet inactivation, on the other hand, was photoreactivated to essentially the same degree in both parents, the diploid, and the segregants; this indicated that different steps were involved at some point in the photoreactivation of mutation and killing. The frequency of mutants (r y) induced in the genic strain remained essentially the same with increasing doses of PR light, while the frequency of mutants (r+ y) induced in the normal stock de-

creased rapidly after a short lag to a saturation level of about one-half that of the initial frequency. It was hypothesized that r+ stocks carried a cellular component, either a chromophore or enzyme, that was necessary for photoreactivation of the extrachromosomal mutation. (BBB)

16537 THE EFFECT OF ULTRAVIOLET LIGHT ON THE INFECTIVITY AND ENZYME-INDUCING CAPACITY OF PAPOVAVIRUS SV40. Carp, Richard I.; Kit, Saul; Melnick, Joseph L. (Baylor Univ. Coll. of Medicine, Houston, Tex.). Virology, 29: 503-9(July 1966).

The oncogenic papovavirus SV40 induces a new cellular (tumor) antigen and causes an increase in thymidine (TdR) kinase in several cell types early in the infectious cycle. Exposure of SV40 to uv radiation, a treatment that affects DNA primarily, was used to study the significance of the virus DNA in the enhancement of TdR kinase in infected cells. The data presented demonstrated that doses of uv radiation which reduced infectivity by about 99.9% completely inactivated the TdR kinase-inducing activity of the virus. Doses of uv radiation which reduced infectivity by about 90 to 98% reduced the amount of TdR kinase induced at 41 hr after infection by only about 25 to 55%. So-called extended TdR kinase synthesis did not occur in cells infected with uv-irradiated SV40 under the conditions studied. The failure to demonstrate extended enzyme synthesis with uv-irradiated SV40 may be related to the absence of the information concerned with enzyme shutoff in the genome of the virus. Another possibility is that the portion of the genome concerned with the induction of enzyme is larger than the area concerned with shutoff. The finding that increasing doses of uv radiation progressively inactivated the TdR kinase-inducing capacity of SV40 suggested that TdR kinase synthesis in infected cells is controlled by the viral nucleic acid. This could be due either to effects which act directly on the coding properties of the virus genome, or to effects on the DNA of the virus which then are translated to the control mechanisms of the cell. (BBB)

16538 A SIMPLE METHOD TO DIFFERENTIATE MYCOBACTERIUM AVIUM FROM NONPHOTOCHROMOGENS BY THE DIFFERENT PATTERNS IN THE LOSS OF ACID-FASTNESS AS THE EFFECT OF ULTRAVIOLET IRRADIATION. Murohashi, Toyoho; Yoshida, Konosuke; Kato, Mutsuko (National Inst. of Health, Tokyo). Amer. Rev. Respirat. Dis., 94: 114-17(July 1966).

Studies on the effect of uv irradiation on the acid-fastness of mycobacteria revealed the marked difference between the avian form strains and the nonphotochromogens. The smears of nonphotochromogens lost acid-fast stainability almost completely after 3-hr uv irradiation at a distance of 10 cm from a germicidal lamp (Mazuda GL 15), while those of avian form strains retained the acid-fast stain. The degree of acid-fastness of avian strains after 1-hr uv irradiation was about 90%. This decreased to about 50% after 3 hr, about 25% after 5 hr, and about 1% after 7 hr of uv irradiation. The nonphotochromogens were generally weaker in acid-fastness than the avian strains. Even strains of nonphotochromogens that were able to grow at 42°C showed the same acid-fast patterns as other nonphotochromogens in reacting to uv irradiation. They were clearly differentiated from avian strains. Three-hr uv irradiation, which resulted in nearly 50% loss of acid-fastness in avian form strains, were enough to deprive approximately 99% of the nonphotochromogens of their acid-fast stain. This difference provided a simple method of differentiation. (BBB)

16539 EXPERIMENTAL CONTRIBUTION TO THE QUESTION OF STERILIZATION WITH ^{60}Co. Schabinski, G. (Friedrich-Schiller-Univ., Jena, Ger.). Deut. Gesundheitsw., 14: 859-61 (1959).

Studies of effects of ^{60}Co irradiation of gram-positive and gram-negative organisms showed that gram-negative bacilli were sensitive to γ radiation at 30,000 to 50,000 rep; gram-positive bacilli and cocci were sensitive at 60,000 to 100,000 rep; and spore formers were sensitive to 1.5 to 2 M rep. Candida albicans and Saccharomyces cerevisiae were sensitive to 30,000 to 40,000 rep. Irradiation tolerance of Escherichia coli was observed to increase as the dose was gradually increased from 30,000 to 70,000 rep. Cells became increasingly pleomorphic but retained staining characteristics. The possibility that this resistance to irradiation may be due to formation of superoxides was studied. Radioresistance was observed to be parallel to insensitivity to H_2O_2 concentrations. Effects of temperature on radiosensitivity were measured by exposure of cells to irradiation at −10, +4, and +20°C. The greatest radiosensitivity of cells was found at 20°C within a range of 33,000 rep. On the basis of these results, it appeared that at doses lower than sterilization doses there were fewer side-effects and that an increase in induction of radioresistance may have occurred. (BBB)

16540 PRODUCTION OF PURPLE PIGMENT BY A MUTANT OF SERRATIA MARCESCENS. Janes, Donald W. (Southern Colorado State Coll., Pueblo); Goldschmidt, Millicent E.; Cash, Howard P.; Williams, Robert P. Tex. Rep. Biol. Med., 24: 489-93(Fall 1966).

Serratia marcescens typically produces a red, cellular pigment called prodigiosin, but mutants producing white or colonies of various other colors were obtained from the parent strain by uv irradiation. A mutant, designated 9-3-3, is described which usually produces colorless colonies but during growth excretes a compound that can be used for synthesis of prodigiosin by certain other colorless mutants. The compound, 4-methoxy-2, 2′-bipyrrole-5-carboxaldehyde is a direct precursor of prodigiosin. Optimal production of this bipyrrole occurs in a complete medium only when phosphate salts are omitted. In the absence of phosphate salts, mutant 9-3-3 also produces purple cellular pigment, which is of interest because of its possible relation to the biosynthesis of the bipyrrole moiety of prodigiosin. Some of the properties of the purple pigment are described and compared to those of prodigiosin. Increasing concentrations of K_2HPO_4 decreased the amount of pigment formed. The purple pigment moved as a single substance when chromatographed on paper or thin-layer plates using several solvent systems. Chromatographic behavior of purple pigment was different from that of prodigiosin. Visible and uv spectra of prodigiosin and purple pigment were different, but the ir spectra showed some similarities. It is concluded that purple pigment and prodigiosin are different substances, although they may be related through some common features of biosynthesis. (BBB)

16541 RELATION OF PHOTOREACTIVATION TO PHOTOENZYMATIC REPAIR OF DNA IN ESCHERICHIA COLI. Rupert, Claud S. (Southwest Center for Advanced Study, Dallas); Antoine, Sandra J. Photochem. Photobiol., 4: 271-5(Mar. 1965).

Photoreaction (PR) of uv irradiated cells and bacteriophage is associated with repair of uv damage to DNA. Cell-free extracts of the mutant E. coli B phr$^-$ lack the power to produce photorecovery of uv-inactivated, bacterial transforming DNA, while extracts of the parent strain possess it under the same conditions. Mixing the B and B phr$^-$ extracts in equal proportions gives intermediate recovery, similar to that obtained by diluting the active B extract 2X with water. Consequently, the inactivity is not caused by any powerful inhibitor of the photoenzyme in the phr$^-$ extract. Rather, the inactive extract lacks this repair function. Photoreactivable damage to cellular DNA does not disappear during illumination of irradiated E. coli B phr$^-$, as it does in similarly treated cells of the parent strain B (and in E. coli B/r). Results of the heat protection test for uv damage demonstrated the repair of transforming DNA by yeast photoreactivating enzyme (PRE) previously heated with cellular nucleic acid. The heat-protective and competitive-inhibitory powers of the preparations possessing them could be abolished by illuminating them with yeast PRE, but not by incubating with it in the dark, as would be expected if these properties were due to photoenzymatically repairable uv lesions in DNA. Photoreactivation in E. coli may result from more than one mechanism, since photoreversal of certain uv-induced mutations can be seen in the deficient phr$^-$ strain, while PR of others (photoreversible in the parent strain) can not be demonstrated. Furthermore, photorecovery of colony-forming ability, apparently related to photoprotection, occurs under the proper conditions with the phr$^-$ strain. It is concluded that the type of photoreactivation lost by mutation to phr$^-$ depends on the cell's capacity for photoenzymatic repair of its DNA. (BBB)

16542 ACRIDINE ORANGE- AND METHYLENE BLUE-SENTITIZED INDUCTION OF ESCHERICHIA COLI LYSOGENIC FOR PHAGE λ. Freifelder, David (Brandeis Univ., Waltham, Mass.). Virology, 30: 567-8(Nov. 1966).

Strains of Escherichia coli lysogenic for phage λ can be induced to produce phage by uv irradiation. Some uv damage can be repaired in E. coli strains possessing a dark-reactivation (DR) mechanism, and in lysogenic strains possessing DR the phage-inducing lesion can also be repaired. However, since in uv-irradiated DR-less strains, death occurs more rapidly than induction, the inducing events must be rare compared to the killing events. The mechanism of lysogenic induction by uv was examined in a system in which repair does not occur, the inactivating lesion occurs at nearly the same frequency as the inducing one, and the inactivation rate is not significantly increased in lysogenic cells compared to nonlysogenic cells. E. coli can be inactivated by visible light (VL) irradiation of cells which have been preincubated in, and thereby sensitized by acridine orange (AO) or methylene blue (MB). The strains used were E. coli UV^r and UV^s lysogenic for λi^{434}. Results of inducing AO- or MB-sensitized UV^r and UV^s with VL showed that both strains are induced and inactivated at the same rate. Furthermore, for small doses, induction occurred at

nearly the same rate as inactivation. It is concluded that AO and MB sensitize λ-lysogenic cells to induction by VL. Lesions which are not dark-reactivated can induce. The lethal and inducing lesions may be the same. (BBB)

16543 ON THE REACTION OF INFUSORIA OF THE GENUS COLPODA TO ^{60}Co GAMMA RADIATIONS. Mavljanova, M. I. (Inst. for Botany, Tashkent, USSR). Pedobiologia, 6: 129-39 (1966). (In German).

Cultures of C. manpasii and C. cucullus were irradiated with doses of 1, 5, 10, 100, 300, 500, 600, and 1000 KR at dose rates of 1080, 1200, 1560, and 2400 R/min from a ^{60}Co source. The treatments increased the reproduction rate and motility of the organisms. At doses of 50 to 100 KR the protozoa multiplied very rapidly, but the velocity of their division was decreased. Depending on the strain their velocity of division resumed its normal rate by the third to seventh day after irradiation. Irradiation doses from 300 to 500 KR caused prolongation of the multiplication time of the organisms. Doses of 600, 700, and 1000 KR, with dose rates of 7800, 29,400, and 36,000 R/min were lethal to the organisms within 3 or 4 days after irradiation. Evidence for production of biologically active substances by C. manpasii after irradiation with doses from 0.5 to 1 KR, given at rates of 960 and 1440 R/min, was obtained. When these infusoria were cultured with Azobacter the N-binding ability of the Azobacter was enhanced, resulting in a 20 to 70% increase in the accumulation of N. The ability of irradiation to cause production of biologically active substances by the infusoria remained effective for about 90 days after irradiation. The treatment of cotton seeds before seeding with infusoria cultures irradiated with doses from 0.5 to 50 KR causes increased germination and enhances development of the cotton seedlings. The biologically active material stimulated plant growth and protected cotton seedlings against effects of the mold Rh. solani. (BBB)

16544 ACTION SPECTRA FOR PHOTOREACTIVATION OF KILLING AND MUTATION TO PROTOTROPHY IN U.V.-SENSITIVE STRAINS OF ESCHERICHIA COLI POSSESSING AND LACKING PHOTOREACTIVATING ENZYME. Kondo, Sohei; Kato, Takesi (Osaka Univ., Japan). Photochem. Photobiol., 5: 827-37 (Nov.-Dec. 1966).

Ultraviolet-sensitive strains of E. coli, H_s30 (uvr$^-$ phr$^-$ arg$^-$), lacking the ability to repair uv damage in the dark (uvr$^-$), lacking photoreactivating-enzyme activity (phr$^-$), and lacking the ability to synthesize arginine (arg$^-$), and H_s30-R (uvr$^-$ phr arg$^-$), having the same auxotrophic marker and the same high uv sensitivity, were derived, respectively, from resistant strain H/r30 (uvr$^+$ phr$^-$ arg$^-$) and its revertant H/r30-R (uvr$^+$ phr$^+$ arg$^-$). H_s30 and H_s30-R have about 25 and 35 times higher sensitivity than H/r30 and H/r30-R for uv-induced killing and mutation to prototrophy, respectively. Efficiency of photoreactivation (PR) of mutation in strain H_s30-R is about 10 times higher than the PR efficiency in the parent strain H/r30-R at wavelengths between 3341 and 4358 Å but not that much higher at 3132 Å. On the other hand, H_s30 shows no PR at any of these wavelengths, although the parent strain H/r30 does show PR of mutation around 3341 Å. These results support the previously described model that PR in H/r30 is an indirect effect of PR light which enhances dark repair. It is concluded that H_s30 and H_s30-R lack dark-repair capacity for uv-induced mutational damage and that the same type of photoreactivable DNA lesions as those responsible for uv killing, i.e., pyrimidine dimers, are the primary cause of uv-induced mutation in the uvr$^-$ strains. PR spectra for killing in H_s30-R and mutation in H/r30-R and H/r30 were obtained and compared, and the quantitative conclusions reached are discussed in connection with the hypothesis that the same kind of lesion (pyrimidine dimer) is the primary cause of mutation in the uvr$^+$ strains as well. (BBB)

16545 EARLY EVENTS IN THE ECLIPSE PHASE OF INFLUENZA AND PARAINFLUENZA VIRUS INFECTION. White, David O.; Cheyne, Ian M. (Univ. of Melbourne). Virology, 29: 49-59 (May 1966).

Ultraviolet irradiation was used to study the role of the cell nucleus in the multiplication of influenza and parainfluenza viruses. While the capacity of cells to support the growth of parainfluenza virus was relatively resistant to preirradiation with uv light, their capacity to support the growth of influenza virus was just as sensitive as the cell-virus complex shortly after infection. Between ½ and 2½ hr postinfection the cell-virus complex acquired resistance to uv irradiation. The findings indicated that cell-coded messenger RNA is required in the early stages of influenza virus multiplication, but plays no role in the replication of viral nucleic acid or any subsequent event. Multiplicity-dependent delay in the multiplication of influenza virus takes place after the synthesis of at least one so-called early protein but before the latest point of action of actinomycin D, before the acquisition of resistance to uv irradiation and before the establishment of interference. (BBB)

16546 RESTORATION OF 5-BROMOURACIL-SENSITIZED ESCHERICHIA COLI STRAIN B AFTER EXPOSURE TO IONIZING OR ULTRAVIOLET RADIATION. Gillies, N. E. (Middlesex Hospital Medical School, London). J. Gen. Microbiol., 45: 97-111 (Oct. 1966).

Strain B of E. coli was sensitized to the action of ^{60}Co γ radiation or uv radiation by incorporating 5-bromouracil into the DNA of the bacteria. Most sensitization was observed after uv irradiation, less after anoxic γ irradiation, and least after aerobic γ irradiation. Incubation of the bacteria for a few hours after irradiation on a nutrient medium which included chloramphenicol generally resulted in extensive restoration of colony-forming ability whether or not the bacteria contained 5-bromouracil. Only after the aerobic γ irradiation of bacteria containing no bromouracil was little restoration obtained. After aerobic or anaerobic γ irradiation the rescue of bacteria containing 5-bromouracil was relatively larger than that observed for bacteria containing no bromouracil. Maximum restoration was obtained after uv irradiation and this occurred to about the same extent, whether or not bromouracil had been incorporated into the bacteria. (BBB)

16547 SUPER-SUPPRESSOR MUTATIONS IN SACCHAROMYCES CEREVISIAE. Gilmore, R. A. (Univ. of Rochester, N. Y.); Mortimer, R. K. J. Mol. Biol., 20: 307-11 (Sept. 1966).

Two haploid strains of yeast of opposite mating types and each containing the same 5 suppressible alleles were irradiated with uv light to induce revertants. Any revertants which proved to be prototrophic for 2 or more of the suppressible alleles was considered to contain a super-suppressor. Of 1053 revertants, 83 super-suppressors were obtained which could be grouped into 8 phenotypic classes. Genetic analysis of some suppressors from 2 classes established a min of 10 separate loci, and crosses of these 10 suppressors with 2 of the previously identified suppressors showed all 12 to be at different loci. Interclass crosses indicated that each phenotypic class probably represents a separate set of loci. A 2-suppressor effect is described, and a model to explain these observations is presented. (BBB)

16548 ELECTRONMICROSCOPY OF THE ANTI-BACTERIAL AGENT PRODUCED BY ESCHERICHIA COLI 15. Mennigmann, H. D. (Univ., Frankfurt am Main). J. Gen. Microbiol., 41: 151-4 (Nov. 1965).

Strain 15 of Escherichia coli, after uv irradiation and further incubation, eventually lyses and releases an antibacterial agent. This agent was originally considered to be a colicine, but evidence is presented that a defective phage is produced. Electron microscopic pictures of such lysates are presented which show a defective phage. Thus, regarding the antibacterial agent produced by E. coli 15, the concept is now favored that it is a defective phage and the possibility of the additional presence of a colicine is left open. Electron micrographs revealed a phage consisting of a polyhedric head (about 600 Å in dia) and a tail (overall length of about 1100 Å, and about 170 Å in dia). In some cases, the head seemed to be empty. The tail is complex: an outer sheath covers an inner core. To this is attached a base plate with at least 3 spikes. No fibers could be detected. The sheath appeared striated and is contractile. This new phage is not much different from E. coli phages of the T-even series, except that its head is smaller. It was named phage ψ because the Greek letter psi is reminiscent of an inner core plus base plate plus 3 spikes. The differences between this defective phage and a bacteriocine and the type of interaction between this phage and E. coli 15 are discussed. (BBB)

16549 STUDIES ON THE PRODUCTION OF FERRIC COLOR-REACTIVE SUBSTANCES BY ASPERGILLUS SPECIES. PART II. KOJIC ACID PRODUCTION BY UV-IRRADIATED STRAINS OF ASPERGILLUS ORYZAE. Ishiie, Shunji (Godo-Shusei Co. Ltd., Matsudo, Japan). Nippon Nogeikagaku Kaishi, 40: 359-63 (1966). (In Japanese).

Aspergillus strains belonging to A. tamarii and A. flavusoryzae groups exhibit the ability to produce kojic acid (KA) in both surface and submerged cultures. Kojic acid production by uv-irradiated strains of Aspergillus oryzae was studied. The results obtained with uv-irradiated cultures showed that all of the surviving strains which possessed the same morphological characters as original strain had the same mode of KA production as original one. Irradiation had a positive effect on both the amounts and rates of KA production, but was ineffective in increasing multiplication of Aspergillus cells. (BBB)

16550 A CHARACTERISTIC OF THE LETHAL EFFECT OF IONIZING RADIATION ON "Hcr$^-$" BACTERIAL STRAINS. Alper, Tikvah (Hammersmith Hospital, London). Mutat. Res., 4: 15-20 (Feb. 1967).

Eight strains, selected by various workers for UV sensitivity (6 of them being Hcr$^-$), have been exposed to ionizing radiation in the presence and absence of oxygen. In all cases the sensitivity in

anoxic conditions of the UV-sensitive strains was greater than that of their parents, and the oxygen-enhancement ratio considerably less. These data support the concept that the mode of x ray damage which is bypassed or repaired in the resistant parents is of a different type from that which is mainly responsible for the oxygen effect. (auth)

16551 MECHANISM OF THE DAMAGING EFFECTS INDUCED BY RADIATION IN BACTERIAL CELLS (A REVIEW). Skavronskaya, A. G. Zh. Mikrobiol., Epidemiol. Immunobiol., 42: 80-5(1965). (In Russian).

A brief review of data on biological and biochemical mechanisms of bacterial cell reactions to radiation is presented. A list of foreign and domestic bibliographies is included. (R.V.J.)

Radiosterilization and Radiopreservation

16552 GRAIN IRRADIATION PLANT. Engineer, 223: 97-8 (Jan. 20, 1967).

The first full-scale application of radiation from a ^{60}Co source for insect disinfestation of grain has been installed in Turkey. Specifications of this irradiation plant that is designed to treat wheat, barley, rye, and maize at rates up to 50 ton/hr, with a dose sufficient to sterilize the insects in the grain are outlined. With the initial loading of 163,000 C of ^{60}Co the plant can continuously treat grain at a rate of 30 ton/hr. The grain irradiation facilities and the process used are described. Safety features and economic aspects of grain irradiation are also discussed. (TSS)

16553 PRESENTATION OF THE PILOT PLANT FOR FOOD IRRADIATION. Lindhout, A. H. Atoomenergie Haar Toepass., 8: 243-4(Nov. 1966). (In Dutch).

A pilot plant for food irradiation to test commercial applications was inaugurated. The purposes of the installation were briefly discussed. The installation has two radiation sources, a γ source and an electron generator. A sketch is given of the γ source. (J.S.R.)

16554 IMPORTANCE OF BACTERIAL SPORES TO THE FOOD INDUSTRY AND POSSIBILITIES FOR DECREASING THEIR RESISTANCE. Farkas, Jozsef (Koezponti Elelmiszeripari Kutatointezet, Budapest). Elelm. Ipar, 19: 48-56(Feb. 1965). (In Hungarian).

An extensive description is given of the heat and radiation resistance of spores of various bacteria, composition and structure of spores, mechanisms of spore resistance, mode of germination of spores, and the possibilities of reducing spore resistance. In experiments which were conducted on Bacillus cereus, germination occurred in nearly 100% of spores after heat treatment and application of germinating stimuli. The spores subjected to 200 Krad irradiation showed a 50-fold decrease in survival rate. A one-hr suspension in a solution containing 0.4 mg/ml adenosine and 0.4 mg/ml alanine further reduced the survival rate from about 40% to 0.05%. It was found that ionizing irradiation made the spores in food products more susceptible to destruction by heat and made storage of the product at room temperature for prolonged periods possible. (BBB)

16555 DEVELOPMENT OF A RADIATION PROCESS FOR SOME INDIAN FRUITS: MANGOES AND SAPODILLAS. Dharkar, S. D.; Savagaon, K. A.; Kumta, U. S.; Sreenivasan, A. (Atomic Energy Establishment, Trombay, India). J. Food Sci., 31: 22-8 (Jan.–Feb. 1966).

A low-dose radiation process, utilizing both radiation and heat, to conserve Alphonso mangoes and sapodillas (Achras zapota) packed in hermetically sealed cans was developed. The fruit, after peeling and slicing, was packed in sanitary cans containing sucrose syrup; enzymes were inactivated by heating for 10 min at 70°C. The cans were then evacuated for 6 min at a vacuum of 28 in. Hg, vacuum doubled-seamed, and irradiated with a total dose of 4×10^5 rad of γ radiation at room temperature. Organoleptic evaluation, vitamin retention, and sterility tests revealed that these processing conditions were optimal and produced an acceptable product. Canned mangoes showed progressively lower acceptability with radiation doses above 4×10^5 rad, as compared with a thermally processed product. Sapodillas, on the other hand, did not show appreciable deterioration when 1.2×10^5 rad was used for sterilization. Cans inoculated with 10,000 Saccharomyces cerevisiae cells and 500 Bacillus subtilis spores and irradiated with 4×10^5 rad were sterile after 2, 4, or 6 weeks of incubation at 30 or 37°C. In other studies with canned foods, similar results were obtained. (BBB)

16556 ON THE WHOLESOMENESS OF γ-IRRADIATED POTATOES. III. FEEDING EXPERIMENTS WITH RATS. Jaarma, M.; Henricson, B.; Bengtsson, G. (Royal Univ., Stockholm). Nutr. Dieta, 8: 296-308(1966).

Wistar rats were fed γ-irradiated potatoes of the variety Vit Drottning (Eldorado). In all experiments the dose was about 200 krad and the potatoes were given raw, with one exception, in which the dose was 14–15 krad and the potatoes were fed steamed. No deleterious effects have been found in rats given maximal amounts of irradiated potatoes. Nor have significant differences been observed between irradiated- and control-potato groups when the feeding period extended over 65 weeks. The experimental diet caused no negative effects, as reflected by general health, growth, and hematological findings in the offspring of the second and third generations. A numerically, but not significantly, higher growth rate in favor of the groups fed irradiated potatoes was observed in some experiments. The same tendency was also present in the second generation (the mother fed irradiated potatoes) and in the third generation (the maternal grandmother and both parents fed irradiated potatoes). The difference in the third generation was 8% in the males. Irradiation of potato tubers raised the sucrose content, calculated to be 1% of the amount of food used. To study the possible effect on weight gain of the increased proportion of sucrose, 1% of sucrose was added to the diet of one group of control animals. This addition significantly increased the growth rate of the control females and almost eliminated the difference between irradiated and control groups. (BBB)

16557 ON THE WHOLESOMENESS OF γ-IRRADIATED POTATOES. Jaarma, Maire; Henricson, Bengt (Royal Univ., Stockholm). Acta Vet. Scand., 5: 238-56(1964).

Potatoes of the Swedish variety Vit Drottning (Eldorado), γ irradiated with germination-inhibiting doses by ^{60}Co (14-15 krad at 175 R/sec) or ^{137}Cs (14-15 krad at 625 R/hr), were fed for 4 months to fattening pigs and pigs for breeding. Wistar rats were also fed irradiated potatoes, but in this case the tubers were given a dose of about 200 krad. No unfavorable effects were observed from the feeding of irradiated potatoes. All the data indicated that the nutritional adequacy of the irradiated and the control tubers was equal. In some cases, the animals even showed an improvement after feeding on irradiated potatoes which was not apparent after feeding on nonirradiated potatoes; for example, there was more rapid growth, higher fertility, and increased hemoglobin values. If the irradiated potatoes actually have properties which stimulate growth, this might be due to the more easily digested carbohydrates which are produced by irradiation. Chemical analysis of carbohydrates in irradiated potatoes provides evidence that this may be true. There was some evidence, although not significant, indicating that the iron content of the liver was lower in animals fed irradiated potatoes. (BBB)

16558 CONTROL OF BACTERIAL CONTAMINATION IN MAPLE SAP STORED IN FIELD STORAGE TANKS BY ULTRAVIOLET IRRADIATION. Kissinger, J. C.; Willits, C. O. (Dept. of Agriculture, Philadelphia). J. Milk Food Technol., 29: 279-82(Sept. 1966).

Methods were developed and tested for using uv irradiation for controlling the growth of microorganisms in maple sap. With this physical method there are no problems of chemically induced off-flavors or harmful chemical residues. Ultraviolet irradiation has no effect on the flavor precursors in sap nor on the delicate maple flavor in the resulting syrup. It was shown that maple sap can be held in storage for as long as 11 days in field storage tanks without deterioration, if the sap is constantly irradiated with uv light of 260 to 300 mμ. The entire surface of the sap must be continually illuminated by the uv light. The storage tank and its feeder lines should be initially sanitized with hypochlorite or other sanitizing solution. Increases in stored sap temperatures caused small increases in bacterial populations, which were not great enough to affect the quality of the syrup produced. High quality syrup could be made from sap stored as long as 11 days under uv irradiation. This was independent of the time when the sap flowed during the sap season. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 16848.

16559 FISSION TRACK ETCHING AS A METALLOGRAPHIC TOOL. Rosenbaum, H. S.; Armijo, J. S. (General Electric Co., Pleasanton, Calif.). J. Nucl. Mater., 22: 115-16(1967).

Track etching was applied to studies of the distribution of atoms in metallic alloy specimens. A polycarbonate polymer was chosen to record the tracks of the fission fragments because its etching characteristics were known. The metallographic sections with their polymer detectors were irradiated. The polycarbonate detectors were then lifted mechanically from the specimens and etched in 6N NaOH at 53°C. This etching treatment developed the tracks of fission fragments without removing the replicated surface topography. (M.C.G.)

Corrosion and Erosion

Refer also to abstracts 16589 and 16593.

16560 OXIDATION RATE OF NIOBIUM–IRON AND NIOBIUM–COBALT ALLOYS AT HIGH TEMPERATURES. Voitovich, R. F. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Zh. Prikl. Khim., 39: 1418-22(June 1966). (In Russian).

The scaling of pure Fe and Co, alloys of Nb with Fe (10, 30, 50, 70, 90 wt %), and Nb with Co (10, 30, 50, 70, 90 wt %) was studied in the 500 to 900°C range in air. The oxidation curves of the alloys showed that the alloying of Nb with Fe and of Fe with Nb caused a substantial increase in the oxidation resistance of the metals; alloying of Nb with up to 30% Co caused a marked increase in the scaling resistance of Nb, whereas the addition of Nb (in amounts up to 30%) to Co gave rise to an extensive scaling of Co at 800 to 900°C. Values of the free energies of possible oxidation-reduction reactions in the scale and their equilibrium constants were calculated for various temperatures for both types of alloys. Results of these calculations indicate that in Nb–Fe alloys, the predominant reaction taking place is the reduction of iron oxides to pure Fe and the formation of Nb_2O_5; this increases the corrosion resistance of the alloys, since the defect phase FeO, which speeds up the oxidation rate, is eliminated from the sphere of the reaction. In the scale of Nb–Co alloys, CoO is reduced to Co; x-ray analysis showed the presence of Nb_2O_5, Co_3O_4, CoO, FeO, and of small amounts of Fe and Co. (ATD)

16561 USE OF AMMONIA TO SUPPRESS OXYGEN PRODUCTION AND CORROSION IN BOILING-WATER REACTORS. Lesurf, L. E.; Bryant, P. E. C.; Tanner, M. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Corrosion, 23: 57-64(Mar. 1967).

Radiolysis of the coolant in nuclear reactors cooled by boiling water resulted in O_2 in the steam and recirculated water phases. This dictated the use of stainless steels as the major circuit materials for these reactors. It was shown that NH_3 additions to the coolant eliminated O_2 production, permitting the use of mild steel for circuit construction with consequent savings in capital cost. Corrosion data are presented for various out-reactor materials (carbon steel, low-alloy steels, stainless steels, Monel alloy 400, Inconel alloy 600) exposed out-of-flux to the coolant of two phase in-reactor loops when operated neutral and with NH_3 addition. Activation of corrosion products from different origins is discussed. Intergranular attack is related to the presence of O_2 or oxidizing radiolytic species in the water. (auth)

16562 HIGH-TEMPERATURE OXIDATION OF TANTALUM SINGLE CRYSTALS. Stringer, J. (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals, 12: 301-17(Apr. 1967).

Single-crystal spheres of Ta were oxidized at 500, 600, 820, and 925°C in an O_2 pressure of 450 torr. The oxidation rate is anisotropic at the higher temperatures with the {100} faces oxidizing slowest and the {110} faces fastest. However, at the lower temperatures the oxidation rate is apparently isotropic. The habit plane of the suboxide plates extending into the metal from the metal/oxide interface was determined to be $\{100\}_{Ta}$ at all four temperatures. Failures in the scale were shown to be related to the pores introduced by the suboxide plates, which may be the cause of the rate anisotropy. (auth)

16563 POROSITY EFFECTS ON THE OXIDATION OF TUNGSTEN. Berman, David (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 38: 780-3(Feb. 1967).

The rate of formation of WO_3 from the internal porous area of a heated W sample, was calculated. The porosity effect was found to increase the oxidation rate by an order of magnitude over an equivalent solid sample. The effusion rate of WO_3 from the sample is obtained by establishing the O_2 and WO_3 molecular distributions within the sample. The boundary conditions of the distributions are set by the partial pressure of oxygen at the surface. The rate of WO_3 effusion (from the porous interior into the surroundings) is determined by the molecular concentration gradient at the boundary, times the appropriate diffusion coefficient. The parameters used in the study correspond to vacuum-system operation of a Cs surface-contact ionizer (temperature = 1400°K; pressure = 10^{-6} torr). Simple slab geometry is considered for the porous W sample; only one side is exposed to oxygen. (auth)

16564 EVALUATION OF SILICIDE COATINGS ON NIOBIUM AND TANTALUM AND A MEANS FOR IMPROVING THEIR OXIDATION RESISTANCE. Lavendel, H. W.; Elliot, A. Grant (Lockheed Palo Alto Research Lab., Calif.). Trans. Met. Soc. AIME, 239: 143-8(Feb. 1967).

The oxidation behavior of $TaSi_2$-coated Ta and $NbSi_2$-coated Nb was studied. These systems had a lower inherent oxidation resistance than $MoSi_2$-coated Mo. Further, diffusion of Si in the Ta– and Nb–Si system was considerably slower than in the Mo–Si system. These factors prohibited the mechanism of selective oxidation of Si, which accounts for the oxidation resistance of $MoSi_2$-coated Mo. The silicide was stabilized by adding suitable modifiers, which increase the thermodynamic stability of the silicate formed during oxidation. Addition of Al to $TaSi_2$ coatings on Ta was effective in moderately increasing the oxidation resistance. (auth)

16565 MECHANISM OF THE SORPTION OF OXYGEN ON THE (100) FACE OF A TUNGSTEN SINGLE CRYSTAL. Zingerman, Ya. P.; Ishchuk, V. A. (Inst. of Physics, Kiev). Soviet Phys.-Solid State (Engl. Transl.), 8: 2394-7(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2999-3003(Oct. 1966).

The interaction of molecular oxygen with the (100) face of a W single crystal was investigated by measuring the work function. It was established that, as a result of this interaction, a number of structures or phases of the adsorbed O_2 film are formed. (auth)

16566 FURTHER OBSERVATIONS ON THE OXIDATION OF ZIRCONIUM IN DRY OXYGEN. Hillner, E. (Westinghouse Electric Corp., Pittsburgh). J. Electrochem. Soc., 114: 237-9(Mar. 1967). (WAPD-T-1899).

The high-temperature oxidation performance of pure Zr was studied. For the method of continuous weight-gain determination, the pre-transition oxidation performances of high-grade sponge Zr and crystal bar Zr were alike in all respects. For continuously weighed specimens, the post-transition kinetics of sponge Zr followed a linear rate equation, whereas crystal bar Zr exhibited parabolic rate behavior. The oxidation performance of Zr appeared insensitive to oxygen pressure in the range from 50 to 400 Torr. The crystal bar Zr oxidized in accordance with a post-transition parabolic rate equation when weight-gain information was obtained by either continuous measurements at test temperature or by employing different specimens for each datum point. When a fixed group of identical specimens were used to obtain the entire kinetic curve by means of interrupted weight determinations on the same samples, linear post-transition behavior was observed. The crystal bar pretransition region and the entire kinetic behavior of sponge Zr appeared unaffected by the mode of weight-change measurement. (D.H.M.)

16567 PLASTIC DEFORMATION OF ZIRCONIUM DURING OXIDATION. Bollenrath, F. (Technische Hochschule, Aachen); Buresch, F. E. Metaux (Corros.-Ind.), 41: 402-4(Nov. 1966). (In French).

The deformation of sheets and tubes produced during the corrosion of Zr or its alloys was previously described and it was affirmed that the deformation appears completely only after the black-white transformation. However, it was clearly shown that during corrosion tests the deformation appears from the beginning of this phenomenon. This applies both to tubes and to fine sheets. From the beginning of the corrosion they undergo multiaxial tension and can pass the elastic limit, which leads to the plastic deformation of the metal. This explains that the resistance to corrosion of Zr and its alloys is a function of the resistance to deformation, that is, of the mechanical properties at the operating temperature. In the case of assemblies it is possible that this deformation can be considerably inhibited by the conditions of assembling. (tr-auth)

16568 OXIDATION OF PURE U IN CO_2 BETWEEN 700 AND 1000°C. Stobbs, J. J.; Woodward, A. J. (Central Electricity Generating Board, Berkeley, Eng.). Corros. Sci., 6: 499-507 (Nov.-Dec. 1966).

Oxidation of U in CO_2 was studied morphologically. On β-Uranium, the oxide was cracked and oxidation was controlled by O^{2-} diffusion through a thin compact layer of UO_2. Self-heating occurred at ≥750°C leading to rapid oxidation rates between 750 and 850°C. Between 900 and 1000°C the oxide was more compact, rates were not excessively high, and self-heating was hardly significant. Carbon in the oxide was predominantly located near cracks around 700°C, but as the temperature increased its distribution became more uniform and its high mobility led to the formation of multi-component reaction-product layers. (auth)

16569 MECHANISM OF THE ACTION OF INORGANIC INHIBITORS. Cartledge, G. H. (Oak Ridge National Lab., Tenn.). Brit. J. Corros., 1: 293-302 (Sept. 1966).

The properties of Tc compounds relevant to inhibition are presented, together with an outline of the hypothesis of electrostatic polarization by XO_4^{n-} ions, which led to the discovery. Results of several studies of the mechanism are given, which demonstrated the extreme effectiveness of the pertechnetate ion, in comparison with other inhibiting anions, even in the absence of oxygen or other oxidizing agents. It was shown that TcO_4^-, CrO_4^{2-}, and MnO_4^- all exert an effect on the metal that does not depend on reduction of the inhibitor. The result of this action is that the metal may be passivated anodically by much lower current densities than are requisite in noninhibiting electrolytes, and with passage of no more charge than is necessary to form the passive film. The nature of the interface between metal and electrolyte in both active and passive conditions is briefly discussed in relation to the alternative reaction paths which lead to active dissolution or to passivation, respectively. The various ways in which the inhibitor may enter into these processes are presented from the point of view of electrode kinetics, as modified by the specific interactions in which the structure of the inhibitor may play a part. In effect, the inhibitor reduces the activity of the metal, as represented by its exchange current, so that it is then capable of being passivated as early as a stainless alloy. (BBB)

16570 MICROSCOPE STUDY OF THE INITIATION OF THE HYDROGEN–URANIUM REACTION. Owen, L. W.; Scudamore, R. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Corros. Sci., 6: 461-8(Nov.-Dec. 1966).

The visible reaction occurring at a U surface exposed to 700 mm hydrogen at 170°C was observed under the microscope. Initial attack was localized and of two types: one readily visible and developing randomly at inclusion sites, the other seen only at relatively high magnification developing with uniform distribution. Rates of formation of attack sites of both types on clean U were found to be high. With increasing thickness of oxide film up to 1000 Å rates were progressively lower. It is proposed that attack sites are formed at local deficiencies in the oxide film around inclusions and through film porosity. (auth)

Preparation and Fabrication

Refer also to abstracts 16591 and 16615.

16571 (NP-16491) JOINING DISSIMILAR METALS BY UTILIZING EXPLOSIVE WELDED INSERTS. Gibson, Donald L.; Yager, Kenneth E. (Missouri Univ., Columbia. Dept. of Mechanical Engineering). July 1965. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of a study to determine if explosively welded bi-metal inserts can be used to join together larger sections of dissimilar metal and to evaluate the resulting physical properties of the joint when various methods of conventional welding were used to attach the bi-metal inserts are presented. The evaluation was performed with special emphasis on such properties as tensile strength of the explosive bond, accelerated corrosion resistance to ambient conditions, and thermal shock properties of the explosive bond. When electron beam welding was used to join the explosively welded bi-metal inserts, very little reduction in strength occurred in the bonded materials. When heli-arc welding was used to join the explosively welded bi-metal inserts, considerable reduction in strength occurred in the explosive weld area. Four years exposure to ambient conditions was simulated. The corrosion attack was slight and had negligible effect on the properties of the explosive weld. In the thermal shock test, an Al-to-steel specimen was cycled between –300 and 212°F. After 100 cycles of this thermal shock, the specimen exhibited no decrease in ultimate tensile strength. (auth)

16572 (RMI-6) QUARTERLY PROGRESS SUMMARY, APRIL–JUNE 1965. (Reactive Metals, Inc., Ashtabula, Ohio). Oct. 10, 1966. Contract AT(30-1)-1405. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: extrudability vs grain structure of natural U; radiation effects on U cores having as-extruded coarse grain; fabrication of U billets by extrusion and upset-forging; and temperature determination of U tubes during formation by extrusion process. (P.C.H.)

16573 (RMI-7) SEMI-ANNUAL PROGRESS SUMMARY, JULY THROUGH DECEMBER 1965 [ON URANIUM FABRICATION]. (Reactive Metals, Inc., Ashtabula, Ohio). Dec. 1, 1966. Contract AT(30-1)-1405. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on fabrication of U fuel elements for SRO by hot precision extrusion, U billet preparation by piercing, water quenching of U extrusions, and fabrication of U fuel elements for NPR by upset-forge route. (P.C.H.)

16574 (WANL-PR-(P)-011) DETERMINATION OF THE WELDABILITY AND ELEVATED TEMPERATURE STABILITY OF REFRACTORY METAL ALLOYS. Quarterly Report No. 11, December 21, 1965–March 20, 1966. Lessmann, G. G.; Stoner, D. R. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Contract NAS 3-2540. 74p. (NASA-CR-72073).

The weldability of three W alloys including W–25Re, unalloyed W, and Sylvania "A" (W-0.5Hf-0.02C) was determined. All were evaluated as 0.035-in. sheet. Both W and W-25Re were converted from arc-cast ingot whereas Sylvania "A" was a powder-metallurgy product. Only nominal weldability was realized in these systems even with preheating to 550°F. All had poor weld ductility as demonstrated by high ductile-to-brittle transition temperatures. Only a minimal recovery of ductility was realized by post-weld annealing. The effect of O_2 contamination on weld strength was determined at room and three elevated temperatures for T-111 (Ta-8W-2Hf), T-222 (Ta-9.6W-2.4Hf-0.01C), and FS-85 (Nb-27Ta-10W-1Zr). The relationships of fracture mode and location, strength, and ductility with respect to thermal history over a wide O_2 contaminating range (to 1000 ppM) were determined and compared. All alloys were sensitive to contamination and, yet, demonstrated an impressive tolerance. (auth)

16575 DEVELOPMENT OF POROUS IONIZER MATERIALS. Kirkpatrick, M. E.; Mendelson, R. A. (TRW Systems, Redondo Beach, Calif.). Contracts AF 33(657)-11726; NAS3-7109. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 562-7(Mar. 1967).

Two separate approaches to the preparation and fabrication of porous ionizers were studied, and experimental data relevant to ionizer evaluation are presented. Closely sized, spherical W powders in six separate size ranges were investigated to determine optimum compaction methods, compaction pressures, and sintering parameters. Laboratory evaluations included density, porosity, permeability, pore parameters, mechanical properties, and ionization properties. Porous structures having surface pore densities to 7.4×10^6 pores/cm^2 were produced and investigated. The concept and preliminary experimental data relating to the preparation of porous ionizer structures for two-phase W–Re alloys are presented. Arc-cast alloys in the two-phase, sigma plus W solid solution field of the binary W–Re system were investigated. Alloys exhibiting suitable microstructures have been prepared and methods developed for the removal of the interconnecting sigma-phase alloy component. Experimental data pertaining to alloy microstructures and phase-removal techniques are discussed. W–Re alloy microstructures exhibiting equivalent surface pore densities exceeding 10 million pores/cm^2 were investigated. (auth)

16576 SUBSTRUCTURAL STRENGTHENING OF A PRECIPITATION-HARDENED MOLYBDENUM ALLOY. Wilcox, B. A.; Gilbert, A. (Battelle Memorial Inst., Columbus, Ohio). Acta Met., 15: 601-6(Apr. 1967).

A study on a precipitation-hardened Mo alloy (Mo–0.48 Ti–0.11 Zr–0.02C) showed that the strengthening effect of fine carbide particles is in very good agreement with predictions of the Orowan mechanism of hardening by nondeforming particles. Additional strengthening, achieved by swaging and wire drawing, was related directly to the fineness of the substructure developed by these operations. Elongated closed cells separated by complex walls of dislocations were developed during swaging and drawing. The yield strength, σ, of such material is related to the average cell width, l, by $\sigma \sim l^{-\frac{1}{2}}$, in agreement with previous work on drawn W and various drawn Fe alloys. (auth)

16577 NIOBIUM MICROWIRE FOR SUPERCONDUCTING MATERIALS. Parusnikov, V. N.; Kunakov, Ya. N.; Grodskii, E. A. Tsvetn. Metal., No. 12, 87-8(Dec. 1966). (In Russian).

Cold drawing of Nb microwire preceded by electrochemical oxidation or by coating with Cu was tested under laboratory conditions. Nb ingots were hot forged into 18-mm bars which were forged, without reheating, in a forging machine to a diam-

eter of 3.6 mm and then cold drawn into wire 0.3 mm in diameter with a graphite lubricant. The wire was electrolytically cleaned, vacuum annealed, and coated either with an oxide film (by anodic oxidizing) or with Cu. The wire was then cold drawn to a diameter of 0.02 to 0.07 mm (Cu-coated) or 0.03 to 0.07 mm (oxide-coated). After removal of auxiliary coatings the wire was coated with Sn or Al by passing the wire, preheated to 750 to 800°C, through a droplet of molten metal followed by electrolytic tinning in acid or a stannate electrolyte. Microwire 20, 50, or 70 μ in diameter was coated with a tin layer 2, 5, or 7 μ thick, respectively. Following this procedure, the laboratory produced 10,000 m of wire 20 to 70 μ in diameter. Cold drawing of microwave with Cu or oxide coating can be used under production conditions. (ATD)

16578 CLADDING OF STEEL WITH NIOBIUM BY VACUUM ROLLING. Krivonosov, Yu. I.; Dolzhenkov, F. E.; Myakshin, O. A.; Zakharov, L. A. Tsvetn. Metal., No. 12, 88-9(Dec. 1966). (In Russian).

Niobium-clad steel sheets were produced by rolling packs consisting of a St. 3 steel plate (9 to 12 mm thick) and a VH-2 niobium sheet (2 mm thick) in a vacuum (4×10^{-3} mm Hg) mill equipped with steel rolls, 166 mm/dia, at 900 to 1200°C with per-pass reductions of 10 to 40%. The width of packs was 50 mm and the length was 140 mm. Strength of the bond between the clad and base metals increased with increasing rolling temperature. The shear strength was 100 Mn/m² (10 kg/mm²) after 30% reduction at 900 to 1000°C, and after the same reduction at 1100 to 1200°C it was 210 to 230 Mn/m² (21 to 23 kg/mm²). The bond strength also increased with increasing per pass reduction. After 10% reduction at 1100°C it did not exceed 100 Mn/m² (10 kg/mm²), and after 30 to 40% reduction it reached 250 Mn/m² (25 kg/mm²). However, high per-pass reduction led to a nonuniform deformation of the layers. Therefore, to ensure a reliable bond and more uniform deformation, it is advisable to roll at 1100 to 1200°C, with 10 to 15% reduction per pass and 30 to 40% total reduction. (ATD)

16579 USE OF BLENDING PROCEDURES AND OF NICKEL ADDITIONS IN THE COMPACTION OF AN ACICULAR ELECTROWON TUNGSTEN POWDER. Gourley, J. W.; Price, C. E. (Mackay School of Mines, Reno, Nev.). J. Less-Common Metals, 12: 294-300(Apr. 1967).

The possibilities of obtaining a dense compact from acicular W powder through the use of hydrogen-reduced powder as a blend and/or the use of Ni as an activating agent were explored. It was found that with a 10% blend and 0.5 wt % Ni a compact of 90% theoretical density could be obtained at 1580°C. Observations in the optical microscope suggested that the grain-boundary film formed by the Ni-rich phase was not continuous. (auth)

16580 GROWTH AND PREFERRED ORIENTATIONS OF LARGE ELONGATED GRAINS IN DOPED TUNGSTEN SHEET. Walter, J. L. (General Electric Co., Schenectady, N. Y.). Trans. Met. Soc. AIME, 239: 272-86(Feb. 1967).

W ingots with and without small amounts of Al, Si, and K were prepared by conventional powder–metallurgy techniques and hot-rolled to 0.001-in.-thick sheet. The ingots were rolled three different ways: initially cross-rolled, then straight-rolled; straight-rolled; and straight-rolled, then cross-rolled. Total reductions were 99.8%. Samples of the sheet were annealed, in vacuo, at temperatures from 1200 to 2200°C. Substructures and textures were determined by transmission electron microscopy and x-ray diffraction. The doping agents formed particles of mullite ($Al_6Si_2O_{13}$), which, on rolling, appeared to form strings of particles aligned parallel to the rolling direction. These strings of particles were associated with an increase in the recrystallization temperature from 1400°C for undoped sheet to 2000°C for doped sheet. The particles also limited lateral grain growth while allowing growth parallel to the rolling direction. This results in the formation by primary recrystallization of large highly elongated grains of specific preferred orientation. The undoped sheet recrystallized to small equiaxed grains. The preferred orientations of the large grains were determined from axis density plots to be $(1\bar{1}3)\langle 691\rangle$, $(0\bar{1}3)\langle 362\rangle$, $(116)\langle 304\rangle$ types for the initially cross-rolled then straight rolled material. These orientations are similar to the orientations of the large elongated grains in doped and heavily drawn tungsten wire. The nucleation of the large grains appears to occur by recovery of certain of the polygonized regions of specific orientation, followed by strain-induced boundary migration. (auth)

16581 SODIUM CAN FABRICATION FOR ZERO POWER REACTORS VI AND IX. Kotora, James Jr. (Argonne National Lab., Ill.). Nucl. Eng. Design, 4: 413-22(Nov. 1966).

The fabrication, loading, sealing, and testing of ¼- or ½-inch thick Na cans for use in the Zero Power Reactors XI and IX at the Argonne National Laboratory are described. The sodium can is a precisely made stainless-steel container, filled with Na and sealed under exacting circumstances to retain its high purity. When completed, such cans are used in mock-up reactor core geometries to simulate Na-cooled reactor cores. (auth)

16582 STEADY STATES DURING HEAT TREATMENT OF NIOBIUM AND TANTALUM UNDER WATER VAPOR. Fromm, Eckehard; Jehn, Hermann (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 120-4(Feb. 1967). (In German).

During heat treatment of Nb and Ta in a water-vapor atmosphere steady-states occurred between the absorption of O_2 as a result of the decomposition of water vapor on the hot sample and the evaporation of volatile oxides. The steady states were investigated quantitatively on Nb and Ta at temperatures ranging from 1850 to 2560°C and at pressures between 6×10^{-6} and 2×10^{-3} torr. Relations were established between water-vapor pressure, annealing temperature, and O_2 concentration in the sample. Rates of O_2 absorption in this temperature range were also determined. (auth)

16583 THE FABRICATION OF FUEL ELEMENTS IN FRANCE. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 63, 12-20(Jan.-Feb. 1967). (In French).

In France the greater part of industrial activity in the fabrication of fuel elements is divided among three families of fuel elements: the fuel elements with metallic U base, fuel elements with oxide base, and laminated fuel elements. The fabrication of these three types of elements is outlined. The principle steps in the fabrication of the oxide base fuels and the laminated fuels are given. (J.S.R.)

16584 SOME PROBLEMS AND NEW WELDING TECHNIQUES APPLIED TO THE CONSTRUCTION OF NUCLEAR REACTORS. Foulquier, Henri. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 63, 32-43(Jan.-Feb. 1967). (In French).

The results of studies centered essentially on problems presented during the construction of the heavy water gas reactor EL-4 are reviewed. The devices constructed for remote welding are described. Their basic characteristics and their operational behavior are discussed. The results obtained are indicated. (J.S.R.)

16585 CHARACTERISTICS OF INDUCTION-COUPLED ARGON PLASMAS AND THEIR USE FOR DIRECT PRODUCTION OF MOLYBDENUM BY THERMAL DECOMPOSITION OF MOLYBDENUM DISULFIDE. Huska, Paul Anthony. Bethlehem, Pa., Lehigh Univ., 1966. 134p.

Thesis.

An induction-coupled plasma facility was designed and constructed with special attention given to its use as a chemical reactor. Induction-coupled argon plasmas were generated at atmospheric pressure using a 10 KW rf generator operating at 4 MC. The enthalpy and electrical coupling efficiency of these argon plasmas was quantitatively measured by steady-state, flow-type calorimetric means over a wide range of generator triode plate power levels. These plasmas were stabilized by the vortex and coaxial jet flow patterns as previously reported, as well as by a new method using an axisymmetric jet with peripheral suction which was developed in this investigation. The new stabilization method produced argon plasmas with measured enthalpies as high as 150 kcal/g-mole in a water-cooled quartz tube. Prior to this, rf plasmas of no greater than 50 kcal/g-mole had been sustained in either cooled or uncooled quartz tubes. The maximum enthalpy possible was not reached due to the limited generator power output available. The direct production of Mo from thermal decomposition of MoS_2 in a jet-suction stabilized Ar plasma operating at atmospheric pressure was quantitatively studied. Neither the use of an induction-coupled plasma for chemical reactions with solid reactants, nor the decomposition of MoS_2 at atmospheric pressure have been previously reported. The effect of the plasma energy content and the rate of molybdenite feed to the plasma on the extent of molybdenite conversion was investigated. A direct linear relationship was found between the plasma energy content and the extent of conversion over the range of plasma energy from 2 to 5 kW. An inverse relation was found to exist between the MoS_2 feed rate to the plasma, and the extent of conversion in the product. The products were analyzed by x-ray-diffraction and standard volumetric chemical methods. Conversions as high as 70% were obtained. (Dissertation Abstr.)

16586 TERNARY ALLOY OF ZIRCONIUM. Baque, P.; Darras, R. (to Commissariat a l'Energie Atomique). Canadian Patent 750,318. Jan. 10, 1967. Priority date June 26, 1963, France.

The addition of up to 3% V and 3% Cu to Zr gives an alloy useful in reactors cooled with pressurized Co_2. Corrosion and creep re-

sistance, strength, and neutron-capture cross section are superior to pure Zr. Good resistance to U diffusion is an added feature. The fabrication process, involving vacuum melting, is described. (F.S.A.)

16587 COLLET FOR WORKPIECE IN ELECTRIC WELDING. Vancott, Leonard R. (to U. S. Atomic Energy Commission). U. S. Patent 3,307,016. Feb. 28, 1967.

An apparatus for welding an end piece to the jacket of a nuclear-fuel element is described. A collet is formed of a stack of wafers whose electrical resistance varies from a minimum at the bottom to a maximum at the top, which maximum is greater than the resistance of the jacket of the fuel element. The jacket is gripped in a central opening formed in the stack of wafers, and the end of the jacket is welded to the end piece protruding from the stack of wafers. The welding current passes through the fuel-element jacket over a relatively large portion of its length, rather than through a small portion. Thus, there is no overheating of the jacket to cause upsetting or enlargement of the end protruding from the collet. (auth)

Properties Evaluations

Refer also to abstracts 16045, 16572, 16619, and 16642.

16588 (ALO–3632-11) QUARTERLY PROGRESS REPORT IN A THERMAL INSULATION STUDY, OCTOBER–DECEMBER 1966. DeWitt, W. D. (Union Carbide Corp., Indianapolis, Ind. Linde Div.). Feb. 10, 1967. Contract AT(30-1)-3632. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Small-scale processing tests were conducted on copper flake opacified Refrasil quartz fiber paper and tantalum foil. Offgassing tests were conducted on all of the candidate insulation materials, and the data are being reduced. Refrasil quartz fiber paper and copper flake opacified Refrasil quartz fiber paper exhibited higher offgassing rates than the other candidates, and experiments are under way to re-evaluate the processing techniques used. Thermal conductivity tests were completed for the nickel foil–Astroquartz cloth composite and the aluminum foil–glass fiber paper composite. Thermal conductivity data for the experiments were reduced, and an equation defining the temperature dependence of the thermal conductivity is presented. The first vacuum enclosure candidate test specimen, Inconel-600, developed leakage after 300 hours of testing. Metallurgical examination indicated that failure was due to oxidation penetration, accelerated by stress. The desirability of another Inconel-600 specimen test will be evaluated during the next quarter. (auth)

16589 (BNL–50034) HIGH-TEMPERATURE LIQUID–METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 4, Number 6. (Brookhaven National Lab., Upton, N. Y.). Dec. 1966. Contract AT(30-2)-Gen-16. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Summaries are presented on various research and development programs in the field of high-temperature liquid-metal technology. Covered are all phases of high-temperature liquid-metal technology, including materials development, corrosion and mass transfer, heat transfer, fluid dynamics, instrumentation, purification, component development, physical properties, thermodynamics, chemical analysis, and power systems. (M.O.W.)

16590 (BNWL-357) PLUTONIUM RELEASE STUDIES. II. RELEASE FROM IGNITED, BULK METALLIC PIECES. Mishima, J. (Battelle-Northwest, Richland Wash. Pacific Northwest Lab.). Nov. 10, 1966. Contract AT(45-1)-1830. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Metallic Pu pieces ranging in weight from 455.5 to 1770 grams were ignited and allowed to oxidize completely in air at a velocity of 525 cm/sec. Release rates of 0.032 to 0.0045 weight percent per hour were found for the bare metal. Covering the ignited metal during oxidation with magnesium oxide sand reduced the release to 2.9×10^{-4} weight percent per hour. The Median Mass Diameter of the particles airborne during the release from the bare metal was found to be 4.2 microns. (auth)

16591 (EURAEC–1806) THE RELATIONSHIP OF NITROGEN CONTENT OF AUSTENITIC STAINLESS STEELS TO STRESS CORROSION. Quarterly Report No. 10, October 1, 1966–December 31, 1966. Report No. 438-10. Cox, Thomas B.; Eckel, John F. (Virginia Polytechnic Inst., Blacksburg, Dept. of Metals and Ceramic Engineering). Contract AT(40-1)-3208. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments are reported for: production of thin foils of Type-304 stainless steel; etching procedure for Type-304 stainless steel; N_2 solubility in AISI Type-304 at 871 and 927°C; and thermodynamic properties of the solution process for N_2 in stainless steel. (P.C.H.)

16592 (IN–1043) STATUS REPORT ON ADVANCED TEST REACTOR BERYLLIUM SURVEILLANCE PROGRAM. Beeston, J. M.; Moen, R. A. (Idaho Nuclear Corp., Idaho Falls). Dec. 1966. Contract AT(10-1)-1230. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The status of the ATR Be Surveillance Program is presented along with pre-irradiation data and capsule designs. Sixty-four capsules containing Be samples were inserted into the ETR in April 1965 to build up irradiation exposure lead time on the ATR Be. These capsules will be transferred to the ATR upon startup of this reactor. (auth)

16593 (N–66-35776) HIGH TEMPERATURE PROTECTIVE COATINGS FOR REFRACTORY METALS. Progress Report No. 1, April 21–July 21, 1966. Rexer, J.; Criscione, J. M. (Union Carbide Corp., Parma, Ohio. Carbon Products Div.). Aug. 10, 1966. Contract NASw-1405. 14p. (NASA-CR–77634). CFSTI $3.00 cy, $0.65 mn.

Continued research for applying protective coatings of Ir on refractory metals and for studying the rate of interdiffusion of Ir with refractory metals (W, Mo, and Nb) is reported. Preliminary equipment modifications were made to adapt an induction heating apparatus for study of the interdiffusion. Excellent temperature control was obtained between 100 and 2000°C for a solid bar of W. (TSS)

16594 (N–67-10758) AN INVESTIGATION OF SOLUBILITY AND DIFFUSION OF OXYGEN IN REFRACTION METALS. Quarterly Report, January–March 1966. Pape, R.; Reed, L.; McRae, R. (Eitel-McCullough, Inc., San Carlos, Calif.). Apr. 1966. Contract NAS3-7626. 46p. (NASA-CR–54649; TR–66-19; QR–3)). CFSTI $3.00 cy, $0.65 mn.

Electric-resistivity measurements were used to determine the solubility limits and diffusion constants of O_2 in Ta, Ta-10W, Alloy T222 (Ta alloy), Nb, Nb-1% Zr, and Alloy FS-85 (Nb alloy). Tentative solubility limits were established for Ta in the range 600 to 920°C. The limits of solubility range from 770 ppM at 598°C to 2265 ppM at 918°C. (auth)

16595 (N–67-10893) IMPROVEMENT OF CREEP STRENGTH AND LOW-TEMPERATURE DUCTILITY OF REFRACTORY METALS BY MEANS OF MECHANICAL TWINNING. Final Report. Edington, J. W. (Battelle Memorial Inst., Columbus, Ohio). Oct. 15, 1966. Contract NASr-100(05). 17p. (NASA-CR–79710). CFSTI $3.00 cy, $0.65 mn.

Several materials were investigated to determine the possibilities of ductility improvement at low temperatures, and twin strengthening at high temperatures. These included a Nb–40 wt % V alloy, chosen for evaluating the high-temperature strengthening mechanism; Nb and W for evaluating ductility at low temperatures; and a commercial FS-85 Nb alloy to test the hardening effect of deformation twins on a technologically important material. Test procedures are described, and mechanical property data are given. In experiments on ductility improvement, it was impossible to introduce mechanical twins without introducing cracks that weakened the material on subsequent testing. In conventional tensile tests, twin strengthening occurred at 600°C in polycrystalline Mo-35 at. % Re alloy; did not occur at elevated temperatures on polycrystalline Nb, Nb–40 wt % V alloy, and FS 85 Nb alloy. Under creep conditions at elevated temperatures, twin strengthening did not occur in the FS 85 alloy. (STAR)

16596 (ORO–3262-3) INTERNAL FRICTION STUDY OF THE MOVEMENT OF TWIN BOUNDARIES. Annual Report, 1966. Reed-Hill, Robert E. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Feb. 15, 1967. Contract AT(40-1)-3262. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on tensile tests in liquid He, and the role of twinning in the plastic deformation of Zr. A method for the investigation of polycrystalline deformation is described. Data on tensile properties of Zr measured in liquid He are tabulated. The development of a theory of strain relaxation at constant stress or stress relaxation at constant strain is also reported. (P.C.H.)

16597 (WANL-PR-(P)-012) EFFECT OF 1000 HOUR THERMAL EXPOSURES ON TENSILE PROPERTIES OF REFRACTORY METAL ALLOYS. Topical Report No. 1. Lessmann, G. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). [1966]. Contract NAS-3-2540. 58p. (NASA-CR–72095).

The effect of 100- and 1000-hour aging on the tensile strength of welds and base metal was determined for the Nb- and Ta-base alloys following thermal exposure in ultrahigh vacuum at 1500, 1800, 2100, and 2400°F. Alloys were tested at 1800, 2100, 2400°F, and room temperature. Out of ten alloys, three displayed excel-

lent stability (FS-85, C-129Y, and SCb-291) and six responded with modest changes in tensile properties (T-111, T-222, Ta-10W, B-66, Cb-752, and D-43Y). The remaining alloy, D-43, averaged in a classic manner, lost strength with a time-temperature dependence during thermal exposure. (auth)

16598 (WAPD-TM-654) CALCULATION OF STRESSES IN PRESSURIZED CYLINDERS WITH EXTERNAL FILLETS USING THE DUZ-1 PHILCO-2000 COMPUTER PROGRAM. Griffin, D. S.; Thurman, A. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Stress distributions in pressurized cylinders with external fillets were calculated using the DUZ-1 computer program. Although the range of r/t and T/t ratios investigated was limited, the results demonstrate the applicability of DUZ-1 to such problems, even for very small fillet radii (r = 0.0625 in.). Pipe and fillet dimensions were chosen to coincide with those being investigated experimentally by the Pressure Vessel Research Committee so as to provide ultimate verification of the numerical method. (auth)

16599 EFFECTS OF HYDROSTATIC PRESSURE ON TERMINAL STRUCTURE AND MECHANICAL BEHAVIOR OF BERYLLIUM. Andrews, C. W.; Radcliffe, S. V. (Case Inst. of Tech., Cleveland). Acta Met., 15: 623-37(Apr. 1967).

Effects of pressures up to 27 kb on the resulting surface microstructure, dislocation substructure, and stress-strain behavior observed after removal of the pressure were examined for annealed Be with the principal objective of establishing the characteristics of pressure-induced defects in such an anisotropic metal. Supplementary studies were conducted on Zn. Be developed less prominent changes in surface microstructure than Zn, in keeping with its lower anisotropy and higher flow stress. With increasing levels of hydrostatic pressure up to some 20 kb, the density of pressure-induced dislocations increased progressively. While these dislocations were principally of the types observed normally in Be on plastic deformation under ambient conditions, some evidence of non-basal slip vectors was obtained, especially for the higher pressures. An additional and unexpected feature observed for pressures of 23 kb and higher was the appearance of large numbers (10^{14} cm^{-3}) of small planar defects, identified as sessile vacancy loops lying on basal planes and having a Burgers vector of c/2. The defects differed from all previously reported dislocation loops in Be with respect to their basal plane habit and non-basal Burgers vector. It is proposed that the defects were formed by condensation of vacancies formed at high pressures by intersection of dislocations generated and moved by the pressure-induced shear stresses. A sharp increase in tensile strain-hardening rate was associated with the appearance of those sessile loops. (auth)

16600 GAS BUBBLES IN THERMOCHEMICALLY DEPOSITED TUNGSTEN. Schaffhauser, A. C.; Farrell, K. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Mater., 22: 106-8(1967). (ORNL-P-2634).

Gas bubbles formed in thermochemically deposited W during simple annealing were studied. In the as-deposited W containing as much as 30 ppM F no bubbles or precipitates could be detected by transmission electron microscopy. In this condition the brittle fracture mode was primarily transcrystalline cleavage. After annealing at temperatures above about half the absolute melting point the room-temperature brittle fracture path became largely intergranular, and gas bubbles were observed on the fracture surfaces, particularly at multiple grain boundary junctions. Growth of the bubbles was rapid at higher temperatures. The bubbles displayed the polyhedral shape associated with equilibrium conditions. (M.C.G.)

16601 MAGNETIC INVESTIGATIONS OF THE SUPERCONDUCTING BEHAVIOUR OF SINTERED COMPACTS OF NIOBIUM AND COPPER-NIOBIUM. Catterall, J. A.; Williams, I. (National Physical Lab., Teddington, Eng.). J. Less-Common Metals, 12: 258-68(Apr. 1967).

Magnetization measurements were carried out on sintered compacts of Nb and Cu + Nb powders. The results showed that porosity and particle size influence the properties in the manner predicted theoretically by Friedel et al. The addition of Cu into the compacts merely acts as a diluent to the properties if the sintering temperature is held below its melting point. Raising the sintering temperature above the melting point of Cu, or severe hot-working, cause a drastic deterioration in properties owing to loss of continuity of Nb. The flux-jumping tendency in the compacts can be reduced either by increasing the porosity or by increasing the proportion of Cu. The latter has the advantage of retaining the greater tensile strength. (auth)

16602 TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS OF A Ta-W-Hf ALLOY. Brown, H. L.; Armstrong, P. E.; Kempter, C. P. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals, 12: 328-30(Apr. 1967). (LA-DC-8322).

Young's and shear moduli at room temperature were calculated and the temperature dependence of Young's modulus determined for a solid solution containing 91.02 at. % Ta, 7.74 at. % W, and 1.24 at. % Hf. The elastic behavior of this fully recrystallized Ta-base alloy was very similar to that of randomly oriented polycrystalline Ta. (M.C.G.)

16603 THE PROPERTIES OF ZIRCONIUM ALLOYS AS CONSTRUCTION MATERIALS IN NUCLEAR REACTORS. PART I. Wiedemann, K. H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Metall, 21: 113-20(Feb. 1967). (In German).

The physical and mechanical properties of Zr alloys are discussed and shown graphically. (J.S.R.)

16604 CREEP IN POTASSIUM AS A FUNCTION OF TEMPERATURE AND PRESSURE. Kohler, C. R. (Naval Research Lab., Washington, D. C.); Ruoff, A. L. J. Mater., 2: 20-6(Mar. 1967).

The change-of-slope method was used to obtain the activation energies and the activation volumes for steady-state creep in K. Two sets of values were obtained depending on the strain-rate range. At low strain rates ($\dot{\epsilon} < 2 \times 10^{-7}$ sec^{-1}), an activation energy of 9.7 ± 0.4 kcal/g-atom (0.42 eV) and an activation volume of 25.2 ± 0.5 cm^3/g-atom (0.55 atomic volume) were obtained; the latter value is at 1 kilobar. At higher strain rates ($\dot{\epsilon} > 10^{-6}$ sec^{-1}) an activation energy of 18.6 kcal/g-atom (0.81 eV) and an activation volume of 44.6 ± 2.4 cm^3/g-atom (0.97 atomic volume) were obtained. (auth)

16605 SOME ELECTRICAL-RESISTIVITY MEASUREMENTS ON CERIUM METALS OF VARIOUS PURITIES. Elliott, R. O.; Miner, W. N. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 239: 166-70(Feb. 1967).

Electric-resistivity measurements were made between room temperature and 1.5°K on five different stocks of Ce metal. Results were correlated with the types, amounts, and distribution of the impurities present. Mg, which appeared to be distributed as a solute throughout the cerium matrix, had a large effect on the residual resistivity; 1 at. % Mg was sufficient to increase the residual resistivity by about 10 μΩ-cm. The formation of β by repeated thermal cycling between room temperature and liquid-He temperature is attributed to the deformation and faulting that occurs during the $\gamma \rightleftharpoons \alpha$ transformation. (auth)

16606 THE EFFECTS OF DEFECTS IN THIN-WALLED 18/8 STAINLESS STEEL TUBING. Brown, E.; Cobb, H. R. W. Nucl. Energy, 253-61(Nov.-Dec. 1966).

Non-destructive methods were used to examine defects in thin-wall 18/8 stainless steel tubing. It was found that defects are most noticeable when the material has the capacity to strain harden. It is felt advisable to use such tubes in an annealed condition. Discussions are included on defects revealed by photo-stress methods, behavior of artificial defects, and use of model tubes for analysis. (J.R.D.)

16607 WETTABILITY OF CHROMIUM, TITANIUM, ZIRCONIUM, AND 1Kh18N9T STEEL WITH SILICATE MELTS. Visotskis, K. K. Zh. Prikl. Khim., 39: 1645-7(July 1966). (In Russian).

The effects of metal composition on its wettability with various silicate melts were studied at 1260°C in argon atmosphere. The object of the work was to gain information pertaining to the metal-to-silicate joints and the glass-metal coatings for metals. For several silicate melts composed of 16 to 33% Na_2O, 20% of MgO, CaO, SrO, or BaO, and 64 to 66.7% SiO_2, the contact angle was measured during wetting of Cr, Ti, Zr, and 1Kh18N9T steel. For silicates containing MgO, CaO, SrO, and BaO the wettability was found to increase in the following order: chromium, 1Kh18N9T stainless steel, zirconium, and titanium. In the case of the melt composed of 33.3% NaO and 66.7% SiO_2, the contact angle for Zr and Ti was found to be substantially greater than for Cr and 1Kh18N9T steel. (ATD)

16608 THE UPSETTING PROPERTIES OF ZIRCONIUM AND ZIRCALOY-2. Buehler, Hans; Wagener, Hans Wilfried (Technische Hochschule, Hanover). Z. Metallk., 58: 136-44(Feb. 1967). (In German).

With the aid of upsetting tests, the stress-strain curves of Zr and Zr-2 were investigated in dependence on strain rate and temperature. For the metals examined the following parameters were determined: The work-hardening coefficient m of the equation, $\lg k_f = \lg k_{f\,I,II,III} + m_{I,II,III} \cdot \lg \phi$; the strain-rate coefficient n of the equation, $\lg k_f = \lg k_{f0} + n \cdot \lg \dot{\phi}$; and the temperature coeffi-

cient S of the equation, $\lg k_f = \lg k_{f0} + S \cdot \Theta$. Furthermore the strain-rate coefficient n was described by the equations $\lg n' = b' \cdot \lg \Theta + j'$. (auth)

16609 NATURE, SIZE, AND DISTRIBUTION OF LATTICE DEFECTS AND THEIR INFLUENCE ON THE HIGH-FIELD PROPERTIES OF THE TYPE III SUPERCONDUCTOR Nb–Zr 25. Hillmann, Hans; Pfeiffer, Irmtraud (Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk., 58: 129-35(Feb. 1967). (In German).

The occurrence, size, and distribution of lattice defects in Nb–Zr 25 were investigated by light and electron microscopy. The size and concentration of dislocations, subbands, and Guinier–Preston zones were in agreement with those required for the pinning-mechanism of the type III superconductor. The formation of Guinier–Preston zones depended on the kinetics of the decomposition of the β phase. The kinetics of β decay was influenced by interstitial impurities. Influence of different kinds of defects on the critical current density is shown. Furthermore the critical current density depended on the kind of distribution of the defects. Referring to this, subbands and subband-boundaries produced by severe cold work were important. (auth)

16610 SURFACE TENSIONS OF Co–Ce AND Pu–Co–Ce ALLOYS AS DETERMINED FROM FROZEN MENISCI. Biery, John C. (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 114: 225-31(Mar. 1967). (LA-DC-6430).

The surface tensions of three Pu–Co–Ce and three Co–Ce alloys at their freezing point were determined from their frozen menisci. A calculational procedure was used in which calculated menisci were compared with experimental menisci. The meniscus shapes were calculated by numerically integrating the Laplace–Young equation. The best surface tension for a given meniscus was found by comparing the computed and experimental menisci at 25 points across the meniscus and by varying the surface tension and contact angle at the outside of the meniscus section until various restraints were satisfied. The meniscus comparing techniques satisfactorily detected and discarded menisci. Of the 28 menisci studied, 15 were found to be acceptable. (auth)

16611 MAGNETIC, SUPERCONDUCTING, AND OTHER PHASE TRANSITIONS WITHIN THE METALLIC STATE. Cohen, Morrel H. (Univ. of Chicago). Amer. Sci., 54: 432-57(Dec. 1966).

In addition to a discussion of various models dealing with the metallic state, the incidence of superconductivity among element groups is considered. A survey of occurrence of superconductivity within the periodic table revealed the following 3 features, each of which are examined: the complementarity between the occurrence of superconductivity and magnetism within the transition series and the simple metals of groups IIB, III, and IV; the absence of superconductivity or magnetism in the noble metals; and in the alkali (IA) and alkaline earth (IIA) metals, only Be is superconducting; all the rest are normal down to the lowest temperatures investigated. The fact that the simple metals of groups IIB, III, and IV become superconducting indicates a reason for the absence of magnetism, namely, that V_{eff} is <0 (where V_{eff} represents the total effective interaction between quasiparticles). Why it is reasonable to expect V_{eff} to be negative in these metals is considered after introducing the notion of the Wigner-Seitz sphere. The criterion for superconductivity is that $V_{eff} = -V_{ph} = V_{ph} + V_c < 0$, where V_{ph} represents the potential energy of attractive interaction between the first and second electrons and V_c that of the other electrons in the system. All of the groups IIB, III, and IV are polyvalent metals with relatively high electron density, small radius, r_s, and hence small V_c. The theory of electron-atom interactions indicates that V_{ph} is relatively small for Al and increases to large values for Hg and Pb. In all cases V_{ph} is large enough to overcome the relatively small V_c and give negative V_{eff} in these metals. The absence of superconductivity in the noble metals is explained in similar terms. The superconductivity of Be is also explained. (BBB)

Structure and Phase Studies

Refer also to abstracts 16580, 16609, and 16611.

16612 (EURAEC–1184) ELECTRON MICROSCOPIC INVESTIGATION OF PHENOMENA ASSOCIATED WITH SOLID SOLUTION OF OXYGEN IN NIOBIUM. Van Landuyt, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Apr. 1965. Contract 082-62-7 RDB. 17p. (EUR-2022.e). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A transformation process in the solid solution of O in Nb is studied by means of electron microscopy and diffraction. Several stages of the process were found by treating the thin foils in the electron microscope and in a furnace under vacuum. The first step consists of a nucleation phenomenon. Nuclei are formed which are composed of small parallel domains of an ordered phase. The projection of the domain boundaries on a (100) plane have the two perpendicular ⟨110⟩ directions. Lateral growth of the nuclei occurs until the whole region is covered with a cross-hatched pattern. Selected area diffraction shows the presence of many supplementary spots in a regular array between the Nb spots. The phenomenon is explained by ordering of the O interstitials on a superlattice of the matrix, and shows striking similarity to the domains observed in Nb foils that were treated as bulk material. Larger lenticular-shaped domains were also observed. These show internal boundaries of the twin type, which lie in {110} planes. A further stage is associated with the appearance of larger platelets, which are also oriented in crystallographic directions. Selected area diffraction over these areas shows no significant difference from the previous stage. Irregular-shaped nuclei were observed in the same study, having a superstructure of the Nb lattice. The lattice spacing corresponds to twice the Nb spacing. NbO_2 was observed as platelets growing in ⟨110⟩ directions on a (111) foil. This sub-oxide phase was epitaxially related to the Nb lattice. It is supposed that all the phenomena observed represent an intermediate stage in the transformation to the sub-oxide and oxide phases of Nb. (auth)

16613 (IS-T–133) ELECTROTRANSPORT OF OXYGEN, NITROGEN, AND CARBON IN VANADIUM. Warner, Jairus Charles (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 80p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. Thesis.

The electrotransport of O_2, N_2, and C in V was studied at 1825 to 1650°C. The samples were in the form of two-fold semi-infinite rods, like diffusion couples, so that under certain conditions the end effects could be neglected. It was found that migration of all the interstitial contaminants is toward the electrically negative pole. Diffusion coefficients were also determined. It was shown that within experimental error the electric mobility is not a function of the electric field but only of temperature. The specific resistivity was determined and a plot of the resistivity function is presented. The published literature on electrotransport of interstitial elements in metals is reviewed. Three hypotheses are made regarding the direction of interstitial migration. (auth)

16614 (NYO–2394-24) OBSERVATIONS OF DISLOCATIONS AND THEIR INTERACTIONS WITH SECOND PHASE PARTICLES IN ALUMINUM–SILICON ALLOYS BY TRANSMISSION ELECTRON MICROSCOPY. Technical Report No. 24. Prince, K. D.; Richman, M. H. (Brown Univ., Providence, R. I. Div. of Engineering). Nov. 1966. Contract AT(30-1)-2394. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Transmission electron microscopy was used to study the interactions of dislocations and particles in hypo-eutectic Al–Si alloys (Al 1.0 wt % Si in particular). Specimens were annealed or strained 5%. They were then spark machined and electropolished until electron transparent. Loops owing to strain of the matrix around particles and to vacancy condensation were noted in the annealed state as were helices after cold work. Heterogeneous nucleation of dislocations was observed. Network formation was initiated at low strain levels but there was little pinning of dislocations due to particles. Particles were seen to act as anchoring point for dislocations in large mesh networks. (auth)

16615 STRUCTURES OF URANIUM EXTRUDED HIGH IN THE ALPHA PHASE. Donaldson, A. D.; Isserow, S.; Russell, R. B. (Whittaker Corp., West Concord, Mass.). J. Nucl. Mater., 22: 16-21(1967).

Conditions were explored for extruding U at temperatures high enough in the alpha phase for at least the core of the extruded rod to be transformed into the beta phase as it leaves the die. This U then is similar in grain size and texture to U conventionally subjected to a separate post-extrusion beta treatment. (auth)

16616 ANOTHER COMMENT ON THE PRE-$\alpha \rightarrow \beta$ TRANSFORMATION IN PLUTONIUM. Liptai, R. G. (Argonne National Lab., Ill.). J. Nucl. Mater., 22: 117-18(1967).

It is shown that the pre-$\alpha \rightarrow \beta$ transformation in Pu may be associated with a reduction of the internal transformation stresses. The transformation temperature is postulated to be dynamic in nature due to the action of tensile stresses resulting from the $\beta \rightarrow \alpha$ transformation and compressive stresses from the $\alpha \rightarrow$ transformation. (M.C.G.)

16617 LATTICE PARAMETER OF HIGH-PURITY THORIUM WITH REFERENCE TO IMPURITY CONTENT AND HEAT-TREATMENT. Blumenthal, B.; Sanecki, J. E. (Argonne National Lab., Ill.). J. Nucl. Mater., 22: 100-2(1967).

The lattice parameters of crystal-bar thorium were checked and effects of heat treatment were determined. Values for a_0 varied from 5.0840 to 5.0897 Å. The lattice parameter increased with impurity content, temperature, and duration of heat treatment. That part of the increase due to oxygen contamination can be

singled out and reversed by taking the oxygen out of solution in a subsequent heat treatment. (M.C.G.)

16618 EQUIATOMIC TERNARY COMPOUNDS OF URANIUM AND ALUMINIUM WITH GROUP VIII TRANSITION ELEMENTS. Lam, D. J.; Darby, J. B. Jr.; Downey, J. W.; Norton, L. J. (Argonne National Lab., Ill.). J. Nucl. Mater., 22: 22-7(1967).

The vertical section between UAl_2 and UFe_2 in the U–Al–Fe ternary system was investigated by conventional techniques. The component C15-type Laves phases were found to have a substantial solubility in one another and are separated by two ternary phases. One of these is the $U(AlFe)_2$ phase, which has the C14-type structure as reported in earlier investigations. The other phase has a well-defined composition corresponding to the stoichiometric formula UAlFe, is stable below 700°C, and can be indexed as having hexagonal symmetry. Other isostructural equiatomic compounds were found to exist in the ternary systems of U and Al with Group VIII transition elements. Certain parallels were noted between this group of equiatomic ternary phases and the E phases. (auth)

16619 STRUCTURE AND MECHANICAL PROPERTIES OF PURE 15 PERCENT Cr–20 PERCENT Ni AUSTENITES HARDENED WITH TITANIUM, AND SOME OBSERVATIONS ON THE INFLUENCE OF BORON ADDITIONS. Dulieu, D.; Aronsson, B. (Swedish Inst. for Metal Research, Stockholm). Jernkontorets Ann., 150: 787-817(1966).

A study was made of 15% Cr–20% Ni–Fe alloys containing Ti and B. The five compositions used contained 2, 3, and 3.8 wt % Ti; 3.7% Ti + 0.022% B; and 3.7% Ti + 0.48% B. After solution treatment (1100°C for 1 hr) x-ray powder patterns showed the presence of a 'TiX' fcc phase (a = 4.242 Å) in the B-free alloys. In both B-containing alloys the hexagonal TiB_2 phase (a = 3.031, c = 3.225 Å) was detected as small (0.4 to 5.0 microns long) platelets. These phases were inert with respect to subsequent ageing. The matrix lattice parameter indicated a negative Vegard's Law deviation for the solubility of Ti (an increase of 0.0044 Å per at. % Ti was obtained). Ageing at temperatures between 600 and 900°C after solution-treatment gave only two intermetallic phases. Optimum mechanical properties were found with spherical particles of the γ' Ni_3Ti phase. This overaged by the two competitive processes of cellular grain-boundary precipitation of η-Ni_3Ti and intergranular coarsening of γ' particles with subsequent transformation to η-Ni_3Ti. Cellular growth was rapid in the 2% Ti alloy and the γ' phase was stable over the greatest range in the 3.0% Ti material while transformation by both processes was most rapid at 3.8% Ti. The effect of B, however, was to slow down the cellular grain-boundary precipitation. Cold work was found to accelerate the initial loss of Ti from solution on ageing at 750°C. There was direct precipitation of small η-Ni_3Ti particles and fragmentation of the growth of cellular regions. Lattice parameter changes, mechanical properties, γ' particle sizes, interlamellar spacings, and the electron microstructures in aged specimens are reported. (INIS-Sweden)

16620 HYDRIDE HABIT IN ZIRCONIUM AND IN UNSTRESSED AND STRESSED ZIRCALOY-4. Babyak, W. J. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Met. Soc. AIME, 239: 252-7(Feb. 1967).

The habit planes for hydride precipitation in large grains of α Zr and Zircaloy-4 were determined in specimens containing 161 and 136 ppM H_2, respectively. In Zr, the hydride platelets precipitated on various pyramidal planes inclined to the basal plane at angles ranging from 10 to 50 deg and 75 to 90 deg. Hydrides were most frequent at inclinations of about 20 and 90°. In Zircaloy-4, hydride plates were inclined to the basal plane at angles ranging from 5 to 25° with the predominant inclination equal to 12°; no platelets were found near the prism-plane position. In both Zr and Zircaloy-4, hydrides were principally, but not exclusively parallel to $\{10\bar{1}1\}$ type planes. When the Zircaloy-4 grains were subjected to tension stresses of 12,100 and 19,400 psi during hydride precipitation, the hydride habit was unchanged except that precipitation favored those habit planes that were more nearly perpendicular to the stress direction. The stress-orientation effect increased with the magnitude of the stress. (auth)

16621 THE MICROSTRUCTURAL CHARACTERIZATION OF COLD-ROLLED ZIRCALOY-4 SHEET. Aqua, E. N.; Owens, C. M. (Westinghouse Electric Corp., Pittsburgh). Trans. Met. Soc. AIME, 239: 155-61(Feb. 1967).

The microstructure in cold-rolled Zircaloy-4 sheet was characterized by transmission electron microscopy and x-ray diffraction line-broadening techniques. The rate of work hardening was measured in terms of microstrains, particle sizes, microhardness, and tensile-yield strength. The tensile-yield strength of prestrained (<10%) Zircaloy-4 sheet was found to be a linear function of the square root of the dislocation density, as predicted by work-hardening theories. (auth)

16622 SOME COMPOUNDS OF THE FORMULA M_5X_3 FORMED FROM RARE EARTHS WITH Sn. Palenzona, Andrea; Merlo, Franco (Univ., Genoa). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 617-22(Apr. 1966). (In Italian).

Eleven new rare earth intermetallic compounds with Sn of the composition M_5Sn_3 have been found from metallographic and x-ray analyses. The M_5X_3 phase appears not to be stable for Ce, Eu, and Yb. Their structure type is that of Mn_5Si_3, and the packing sequence is briefly described. Lattice constant values plotted vs. rare earth trivalent ionic radius show a linear decrease from La to Lu. (auth)

16623 STRUCTURE OF INTERMETALLIC COMPOUNDS OF RARE EARTHS OF THE FORMULA MSn_2. Iandelli, Aldo; Palenzona, Andrea (Univ., Genoa). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 623-8(Apr. 1966). (In Italian).

Micrograph and x-ray examination of the Sn-rich part of the rare earth–Sn systems showed the existence, from La to Lu, of a stable phase corresponding to the MX_2 composition, while for the following elements (including Y) a phase with the formula MSn_2 was stable. Eu and Yb behave differently because of their divalency. The structure was determined from $GdSn_2$ to $LuSn_2$ by single-crystal x-ray analysis; the orthorhombic $ZrSi_2$ type was found. For La, Ce, Pr, Nd, and Sm this phase appears not to be stable and for the system Ce–Sn the compositions Ce_3Sn_7 and Ce_2Sn_5 were found to be homogeneous. Lattice constant values are reported, and the existence range and structure type for the MX_2 compounds of the rare earths with Si, Ge, and Sn are discussed. (auth)

Radiation Effects

Refer also to abstracts 16572 and 16592.

16624 INFLUENCE OF RADIATION ON THE CORROSION OF ZIRCALOY-2 IN AQUEOUS SOLUTIONS AT HIGH TEMPERATURES. STUDY OF ZIRCONIUM ALLOYS FOR USE IN SUPERHEATED STEAM. Blanchet, J.; Coriou, H.; Grall, L.; Mouhot, R.; Peiras, M. (CEA, [Paris], France). J. Nucl. Mater., 22: 55-67 (1967). (In French).

The influence of fast-neutron irradiation on the corrosion of Zircaloy-2 in an aqueous high-temperature environment was investigated. Experiments showed that, under certain circumstances, irradiation could increase the proportion of hydrogen absorbed by the metal. The oxidation remains practically unchanged. On the other hand, evidence is presented for the detrimental effect of high purification of Zr on its corrosion resistance in demineralized water (360°C) and particularly in superheated steam (400°C). In this case, the attack is reduced by adding small quantities of iron to the metal. The behavior of Zr–Fe2% and Zr–Fe1%–Cu1% alloys in superheated steam is reported. (auth)

16625 EFFECT OF IRRADIATION ON THE HIGH-STRAIN FATIGUE BEHAVIOUR OF A LOW-CARBON AND A LOW-ALLOY STEEL. Wood, D. S.; Johnson, E. R. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Iron Steel Inst. (London), 205: 305-8(Mar. 1967). (TRG-Report-1277; JNPC-MWP-SSG/P (66)-49).

High-strain bending fatigue tests were carried out at ambient temperature on a low-C, high-Mn steel and a low-alloy steel after irradiation at ~140°C to doses of $\sim 1 \times 10^{20}$ n/cm² (>1 MeV). The results indicated that irradiation has a small effect on the high-strain fatigue behavior. At total strain ranges above about 3%, irradiation reduced the number of cycles to failure, but below this strain level the number of cycles to failure was increased. Since engineering structures are likely to operate at total strain ranges below 1%, it was concluded that in practice irradiation should not reduce the number of cycles to failure and may even be beneficial. (auth)

16626 EFFECT OF IRRADIATION TEMPERATURE ON STRENGTH AND MICROSTRUCTURE OF STAINLESS STEEL. Bloom, E. E.; Martin, W. R.; Stiegler, J. O.; Weir, J. R. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Mater., 22: 68-76(1967). (ORNL-P-2691).

The effects of irradiation at temperatures between 93 and 454°C on the room-temperature mechanical properties and electron microstructures of AISI type 304 stainless steel were determined. irradiation at temperatures between 93 and 300°C produced a high density of defect clusters on the order of 100 Å in dia, which were responsible for an increased yield stress. After irradiation at 371°C practically no defect clusters were observed and the yield stress was lower by a factor of two. At irradiation temperatures of 371°C and higher, precipitates formed within the grains. Deformation (10% by rolling) in a specimen containing the defect clusters was concentrated in very narrow slip bands, while in a specimen containing precipitate particles, the deformation was homogeneous. (auth)

16627 NEUTRON DAMAGE TO REACTOR MATERIALS. Nucleonics, 25: No. 1, 49-52(Jan. 1967).

Neutron damage to pressure vessel steels such as Hy-80, A-212B, A-302-B, and A350-LF3 is examined. Data and discussion are included on microstructural changes, failures, annealing effects on damage, and effects of H_2 on brittle failure. Embrittling effects of radiation on stainless steels are also discussed emphasizing the effects of He production and void clusters. (J.R.D.)

16628 EFFECT OF Mg ON THE RESTORATION OF Al IRRADIATED WITH FAST NEUTRONS AT 78°K. Frois, Colette; Dimitrov, Omourtague (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C, 263: 1496-9(Dec. 19, 1966). (In French).

The presence of small quantities of Mg in Al increased the resistivity excess introduced by irradiation at 78°K. This addition caused the appearance of an important supplementary restoration stage located between 90 and 164°K. It corresponded to faults being eliminated after a small number of jumps with an activation energy of 0.40 ± 0.003 eV. (tr-auth)

16629 PROPERTY CHANGES INDUCED BY ELECTRON BEAM EXPOSURE IN VARIOUS SEMICONDUCTOR AND DIELECTRIC MATERIALS. Sivertsen, David R.; Cecil, Olin B.; Haberecht, Rolf R. (Texas Instruments Inc., Dallas). Contract AF 33(615)-2882. pp 279-318 of Proceedings of the Eighth Annual Electron and Laser Beam Symposium. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966.

Electron beam energy from 50 to 150 keV was focused on selected substrate materials to create discrete property changes in high resolution geometrical areas. Changes in resistivity, dielectric constant, junction depth in semiconductor materials and methods of controlling such changes are examples of the investigations conducted. A spectrum of beam power levels ranging from practically zero power density to greater than 1 MW/cm^2 was examined as a means of relating the electron beam energy to the structural, mechanical and electrical changes observed. Various analytical techniques are used to support explanations of observed phenomena. (auth)

16630 EFFECTS OF IRRADIATION AND HEAT-TREATMENT ON THE HIGH TEMPERATURE TENSILE PROPERTIES OF AUSTENITIC STAINLESS STEEL. Roberts, A. C.; Harries, D. R. 34p. (CONF-660627-12). DTIE. Gmelin, AED-CONF-66-198-17.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

The effects of irradiation on 18-10 stainless steel containing 0.59 to 0.63 wt % Nb and 20-25 stainless steel containing 0.59 wt % Nb are reported. It is postulated that B has a dual role in high temperature embrittlement of irradiated austenitic steels and Ni-base alloys in that a $^{10}B-^{7}Li$ reaction forming He in the lattice is detrimental but that B itself has a beneficial effect. The presence of He bubbles and of massive $M_{23}C_6$ and NbC_6 particles at grain boundaries is shown in electron micrographs. Results are also shown for solution treated samples which were aged for 100 hr at 750°C after irradiation. It is concluded that increasing B content accelerates formation of $M_{23}C_6$ precipitates, reduces density of fine NbC_6 particles formed at grain boundaries, during aging at 650 to 750°C, and that embrittlement of austenitic steels after irradiation in thermal reactors is due primarily to formation of He by transmutation of the ^{10}B isotope and to the detrimental effect of He bubbles at grain boundaries. (P.G.C.)

16631 EFFECTS OF IRRADIATION ON THE HIGH TEMPERATURE PROPERTIES OF AUSTENITIC STEELS AND A PRECIPITATION HARDENED NICKEL ALLOY. Bell, I. P. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Standring, J.; Pfeil, P. C. L.; Broomfield, G. H.; Bagley, K. Q.; Fraser, A. S. 27p. (CONF-660627-10). DTIE. Gmelin, AED-CONF-66-198-20.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

The effects of thermal and fast neutron irradiation on the high temperature mechanical properties of several austenitic steels and a precipitation hardened Ni alloy were studied. Results are presented on the influence of neutron dose, irradiation temperature, strain rate, composition, and heat treatment on the magnitude of irradiation embrittlement. Fast neutron dose appears to produce a greater effect than thermal dose for the same level of He generation. Preliminary evidence of an effect of irradiation on the creep rate of stainless steel type 316L tubes at 650 C is given. (auth)

Ceramics and Cermets

Refer to abstract 17270.

Preparation and Fabrication

Refer also to abstracts 16583 and 17538.

16632 (BAW-3460-1) RECYCLE URANIUM FABRICATION PROGRAM. Quarterly Technical Report No. 1, May 1–September 30, 1965. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Contract AT(30-1)-3460. 49p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and construction of a pilot plant to demonstrate the direct refabrication of U-233 is described. This is a novel method whereby the fuel is deactivated and then processed rapidly before the gamma activity grows to an unsafe level. The pilot plant has three major parts: a glove-box line for fuel material preparation; the sol-gel method is used to convert uranyl nitrate and thorium nitrate tetrahydrate feed into a high-density ThO_2-UO_2 powder; a glove-box line for fuel rod fabrication by vibratory compaction of the powder; and a pool, in which the fuel rods are stored, shields the gamma activity which keeps growing while the required number of rods are being fabricated; an underwater assembly machine then mechanically inserts the rods into a fuel assembly. The pilot plant was successfully tested with about 350 kg of natural material before being operated with 85 kg of oxide containing approximately 2.5 kg of U-233. A 13 by 13 demonstration fuel assembly, typical of those used in water reactors, has been fabricated. (auth)

16633 (INR-701/XIV/PS) SOME EXPERIMENTS ON VIBRATIONAL COMPACTING B_4C FOR REACTOR CONTROL RODS. Rutkowski, W.; Szteke, W.; Wieczorkowski, M. (Institute of Nuclear Research, Warsaw (Poland)). Mar. 1966. 20p. Dep.

Some experiments on vibrational densification of B_4C for reactor control rods were made. Higher densities of the B_4C cores were obtained using the hot-pressing technique. Lower densities could be obtained in a vibrational densification process. The control rods were tested in the reactor. Experimental results are presented. (auth)

16634 (ORNL-TM-1712) FABRICATION OF TARGET ELEMENTS FOR THE HIGH-FLUX ISOTOPE REACTOR. Sease, J. D. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 113p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thirty-seven High-Flux Isotope Reactor target elements, 31 of which will comprise the first High-Flux Isotope Reactor target assembly, were fabricated. The ⅜-in.-dia Al clad elements each contain 8 g of ^{242}Pu in the form of 35 Al-jacketed pellets of PuO_2 dispersed in Al and pressed to 90% of theoretical density. The pellets were sealed by welding in a He-filled finned Al tube, which was then canned in a cylindrical Al sheath. In addition, 38 simulated High-Flux Isotope Reactor elements that contain 10% enriched UO_2 and Ta to match the heat generation and cross section of the ^{242}Pu target elements and 19 High-Flux Isotope Reactor target elements that each contain 10 g ^{242}Pu for irradiation at Savannah River Laboratory were fabricated. The design and fabrication of these elements are described along with results of examination of the completed elements, including photographs, radiographs, and complete dimensional data. In the description of the fabrication procedure two developments of major significance are discussed. One is the development of a blending-dispensing technique for the PuO_2-Al core mixture. The second is a unique welding joint design and welding procedure that minimizes the "blowout" problem in closure welds on the ⅜-in.-dia thick-walled Al target tubes. (auth)

16635 (Y-1571) GADOLINIUM OXIDE–30 WT PERCENT ALUMINUM OXIDE COMPACTS. Trent, Paul E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 10, 1967. Contract W-7405-eng-26. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Pellets made of 70 wt % Gd_2O_3-30 wt % Al_2O_3 were fabricated with densities >99% of theoretical. Three of these compacts were ground to specific dimensions and, using interferometer techniques, the thermal expansion coefficient of this material was determined for the temperature range of 25 to 900°C. (auth)

16636 PHOSPHATE BONDING OF ZIRCONIA. Bremser, A. H.; Nelson, J. A. (Univ. of Illinois, Urbana). Amer. Ceram. Soc. Bull., 46: 280-2(Mar. 1967).

ZrO_2 grains can be bonded to form refractory shapes by combining with H_2FPO_3 acid and $NH_4H_2PO_4$, and curing the mixture at 260°C. The material can be cast in place or formed in molds. Studies were made to determine the modulus of rupture of this material as a function of temperature. When CaO-stabilized ZrO_2 was bonded by this method, discontinuities appeared in the strength–temperature curve and it was indicated that the temperature at which the material could be used under sustained heating was appreciably lower than that for sintered stabilized ZrO_2.

The bond for monoclinic ZrO_2 was ZrP_2O_7, and a reaction mechanism leading to its formation is proposed. (auth)

16637 THORIA SINGLE CRYSTALS GROWN BY VAPOR DEPOSITION IN A SOLAR FURNACE. Laszlo, Tibor S.; Sheehan, Paul J.; Gannon, Richard E. (Avco Corp., Wilmington, Mass.). 18p. (CONF-660640-2). DTIE. Gmelin, AED-CONF-66-187-5.

From International Conference on Crystal Growth, Boston.

Techniques developed to produce single crystals of ThO_2, from the vapor state, by heating polycrystalline ThO_2 rods in a solar furnace are described. (P.G.C.)

16638 PLASMA SPRAYED CERAMIC-METAL COMPOSITE COATINGS. Hecht, N. L. (Univ. of Dayton, Ohio). 19p. (CONF-660505-13). DTIE. Gmelin, AED-CONF-66-103-22.

From American Ceramic Society Meeting, Washington, D. C.

Data are given on properties of metal-modified ceramic coatings deposited from premixed powder blends by plasma spraying. Effects of composition, particle size, configuration, and thermal properties of the powders, and the influence of input power and spray distance are evaluated with reference to bond strength and thermal shock resistance of the coatings. (P.G.C.)

Properties Evaluations

Refer also to abstract 15900.

16639 (CU-3553-6) ELECTRONIC PROPERTIES OF REFRACTORY MONOXIDES HAVING INTRINSIC LATTICE VACANCY CONCENTRATIONS. Annual Progress Report, January 1, 1966–December 31, 1966. Denker, Stephen Paul (Columbia Univ., New York. Dept. of Electrical Engineering). Jan. 1, 1967. Contract AT(30-1)-3553. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Single crystals of TiO, VO, $ScVO_2$, $ScTiO_2$ were prepared and studies were made on their electronic properties. The Hall effect was measured in Cu. The theory of bonding and stability of refractory phases is discussed at length, and NMR studies were made on VO. (P.C.H.)

16640 (N-67-10757) STEADY STATE CREEP OF DISPERSION-STRENGTHENED METALS. Final Report. Wilcox, B. A.; Clauer, A. H. (Battelle Memorial Inst., Columbus, Ohio). Aug. 19, 1966. Contract NAS3-7615. 49p. (NASA-CR-54639). CFSTI $3.00 cy, $0.65 mn.

The high-temperature creep behavior of recrystallized Ni–ThO_2 alloys was studied using vacuum constant-stress creep conditions. Five alloys, containing different volume fractions of ThO_2 and different ThO_2 particle-size ranges were creep tested at various stresses (nominally 2,000 to 15,000 psi) and temperatures (nominally 600 to 1050°C). Emphasis was placed on rationalizing the mechanical behavior in terms of the structural changes occurring during creep deformation. Mechanical and structural studies indicated that the rate-controlling creep process was the climb of edge dislocations over ThO_2 particles. A modified version of the Ansel–Weertman climb theory was developed. The theory relates the steady-state rate to stress, temperature, and the ThO_2 particle size and spacing. (auth)

16641 (TID-23684) RESEARCH IN MEASUREMENT OF DIELECTRIC PROPERTIES OF MATERIALS TO EXTREME TEMPERATURES. Final Report. Stowe, R. W.; Townsend, W. T. (Melpar, Inc., Falls Church, Va.). Nov. 1966. Contract AT(29-1)-789. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A research and development effort to extend the temperature range of dielectric measurements of refractory dielectric materials beyond 1650°C is described. VSWR measurements in a shorted coaxial line were selected as the most promising method, eventually supplemented by techniques of time domain reflectometry. A special high temperature vacuum furnace and several experimental coaxial line assemblies were designed and constructed. Above 1700°C, severe difficulties were encountered as a result of unsuppressed thermionic emission from the walls of the coax line, causing significant impedance variations, and preventing dielectric measurements. The nature of the interaction between the emission and the measurement system was investigated. (auth)

16642 THE K_β GROUP OF LINES IN THE X-RAY FLUORESCENCE SPECTRUM OF SCANDIUM IN THE METAL AND IN SOME OF ITS HIGH-MELTING COMPOUNDS. Zhurakovskii, E. A.; Vladimirova, A. A.; Dzheganovskii, V. P. Dokl. Akad. Nauk SSSR, 170: 548-51(Sept. 21, 1966). (In Russian).

The structure of the valence bands in metallic Sc, ScC, ScB_2, ScN, and Sc_2O_3 was investigated in a study of the fine structure of K_β emission lines in these materials. Because of low stability of metallic Sc and some of its compounds, the samples were placed in a vacuum and excitation was brought about by means of a sealed Cu tube. The $(10\bar{1}0)$ plane of a bent quartz crystal was used for analyzing the spectrum. The resolving power of the spectrograph was 10,000. Except for a small shift (1 eV toward the long wavelength side) observed for the ScC the short-wavelength side of the K_{β_1} line remained unchanged in shape and position. The shape and position of the K_{β_2} line appears to be most sensitive to the changes in chemical bonding. In contrast to the shape exhibited by Sc, in its compounds the K_{β_2} line shows two distinct maxima. In the compounds where the covalent and ionic contributions to bonding are stronger, the intensity of the short-wavelength maximum is less. ScB_2 shows the strongest tendency toward covalent bonding. The position of the two peaks for ScB_2 supports the idea that the short-wavelength maximum corresponds to the metallic Me–Me bond and the long-wavelength maximum to the covalent Me–B bond. The spectrum of ScC shows two approximately equivalent maxima, both shifted by about 2 eV toward the shorter wavelength. This is in good agreement with previous notions that the strong bonding forces in high-temperature transition metal compounds exist because of an almost equivalent contribution to bonding of the covalent and metallic d electrons. The spectrum of ScN shows the largest difference between the two maxima. The short-wavelength maximum has the higher intensity and width. The increased contribution of the 2p states of N to the 3d band of Sc increases the probability of emission. The metallic nature of bonding in the nitride is supported by the disappearance of the long-wavelength maximum of the K absorption edge (reported previously) and the closeness of approach between the K_{β_2} emission line (2p + 3d states) and its satellite (2s states of the metalloid). It follows from this that the separation between the K_{β_2} and K'_β lines can, to a certain degree, be used to characterize the energy levels of the valence bonds of the metal and the metalloid. Whenever these lines come close, one can expect the metallic exchange interaction to prevail over the covalent interaction. Among the high-temperature compounds involving transition metals of the first period, ScN, TiC, VC and CrB show the greatest degree of approach between K_{β_2} and K'_β (the sum of the valence electrons among the interacting atoms approaches a stable octet). This characteristic of the high-melting compounds leads one to suspect that certain regularity exists in their energy spectra. The melting points of the Sc compounds decrease in the same order (ScN → ScC → ScB_2 → Sc_2O_3), in which the 2s and 2p + 3d bonds separate. (ATD)

16643 STUDIES AND METHODS FOR IMPROVING THE THERMAL RESISTANCE OF HOT-PRESSED ZIRCONIUM DIOXIDE. Alekseenko, L. S.; Kainarskii, I. S.; Degtyareva, E. V. (Scientific-Research Inst. of Refractory Materials, Ukrainian SSR). Ogneupory, No. 12, 40-5(Dec. 1966). (In Russian).

Thermal resistance of ZrO_2 specimens hot-pressed in graphite containers at 150 kg(force)/cm^2 at 1800°C produced a microfissured structure resulting from slow cooling to 1000 to 800°C. The microfissured structure reduced the coefficient of thermal expansion and modulus of ductility of the moldings. Additions of 25% and more of non-stabilized ZrO_2 improved the thermal resistance of moldings of preliminary stabilized ZrO_2. The maximum thermal stability was observed in slowly cooled ZrO_2 moldings stabilized by CaO. (R.V.J.)

16644 WETTING OF URANIUM CARBIDE. Hodkin, E. N.; Nicholas, M. G.; Poole, D. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 22: 88-96(1967). (AERE-R-5243).

The wetting of UC of varying stoichiometry by Cu, Au, Ag, and their dilute alloys at temperatures of 1100 and 1130°C was examined using the sessile-drop technique. Marked interfacial reactions occurred in all systems and were accompanied by time dependent contact angle decreases. Stoichiometry had relatively little effect on the wetting behavior. (auth)

16645 HOT-PRESSING OF BERYLLIA AND ZIRCONIA. Amato, I.; Colomb, R. I.; Ravizza, M. (FIAT, Turin). J. Nucl. Mater., 22: 97-9(1967).

Cylindrical bodies of BeO and ZrO_2 were hot-pressed for 1 hr at temperatures between 1100 and 1400 and 1200 and 1400°C, respectively, at pressures from 1000 to 8000 psi. The relative densities and the corresponding apparent critical shear stresses are presented. It was concluded that the approximate values of critical shear stress for BeO at 1200°C and for ZrO_2 at 1250°C should be about 1900 and 2300 psi, respectively. (M.C.G.)

16646 PROPERTIES OF TANTALUM DIBORIDE–ZIRCONIUM DIBORIDE ALLOYS CONTAINING CHROMIUM. Dergunova, V. S.; Timonin, P. L.; Kuzin, A. N.; Tseitlin, V. Z. Tsvetn. Metal., No. 12, 84-6(Dec. 1966). (In Russian).

TaB_2–ZrB_2–Cr alloys containing 20, 25 and 30% of ZrB_2 and 3 to 10% Cr were obtained from ZrB_2 (79.6% Zr, 19.67% B, 0.01% C), TaB_2 (89.18% Ta, 9.97% B, 0.01% C), and 99.9%-pure Cr powders

by compacting at 2100 to 2200°C under a pressure of 220 kg/cm² and homogenization at 2000°C in an Ar atmosphere. Depending on the composition, the porosity of alloys varied from 0.5 to 3 to 4%. The alloys consisted mainly of a solid solution of ZrB_2 in TaB_2 with a microhardness of 2900 to 3300 kg/mm², and a solid solution of CrB in TaB_2 with a microhardness of 1000 to 1200 kg/mm². In addition, fine grains of a third phase, probably CrB, were observed along the second-phase grain boundaries. The composition dependence of the melting temperature of TaB_2-ZrB_2-Cr alloys is shown. Increasing the Cr content from 3 to 10% lowered the strength (hardness) of the alloys both at room and at elevated temperatures, but increased their oxidation resistance. (ATD)

16647 DUCTILITY OF SINTERED UNWORKED MOLYBDENUM–CARBON ALLOYS. Milner, A.; Bergstrom, T. R. (Minnesota Mining and Manufacturing Co., St. Paul). J. Less-Common Metals, 12: 253-7(Apr. 1967).

Data are presented to show that greatly improved ductility and strength can be obtained in unwrought sintered Mo by addition of C in amounts up to 5600 ppM. It is proposed that although C generally embrittles Mo it can be introduced in such a manner as to promote ductility in Mo by reducing its O_2 content. Mo containing 3100 ppM C showed ultimate tensile strengths of 83,000 psi and elongations of 25% in the as-sintered condition at room temperature. (auth)

16648 METALLOGRAPHIC INVESTIGATIONS ON WC SINGLE CRYSTALS. Malli, M.; Hillnhagen, E. Prakt. Metallog., 4: No. 1, 24-7(Jan. 1967).

The tested planes of WC single crystals (corresponding to basal and prism planes of a hexagonal lattice) showed important anisotropic properties: differing etching behavior and differing formation of etch-pits were observed at these planes. Due to the high symmetry of the basal plane, the microhardness, which measured 2000 kp/mm², was widely isotropic. The lowest microhardness of 1300 kp/mm² was determined at prism planes in a direction parallel to basal planes. Although WC crystals are called brittle in the literature, slip lines caused by plastic deformation occur next to microhardness indentations. Thereby plastic deformation, as can be measured macroscopically with pure sintered WC (without binder phase) and industrial hardmetals, also can be understood. (auth)

16649 MECHANICAL PROPERTIES OF DISPERSIONS OF THORIA IN BERYLLIA. Veevers, K.; Rotsey, W. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Mater. Sci., 1: 346-53(Nov. 1966).

Behavior of the 2-phase ceramic system $BeO-ThO_2$ as a function of ThO_2 particle size and concentration was studied by measuring changes in strength and Young's modulus. Modulus of rupture measurements were made by the 4-point bending of cylindrical specimens, and Young's modulus was calculated from the deflection of rectangular beams. Examination of matching fracture faces showed that cracks passed through ThO_2 particles, indicating they were bonded to the matrix. At 1.6 vol % ThO_2, the strength of a dispersion depended on the ThO_2 particle size; ~5-μm particles caused little change from 33,000 lb./in.² (23.1 kg/mm²) for pure BeO, while with ~110-μm particles the strength was 20,000 lb/in² (14.1 kg/mm²). The strength of 1.6 vol % ~200 μm dispersions increased with test temperature in the range 20 to 400°C, indicating the presence of internal tensile stresses, caused by the differing coefficients of thermal expansion of BeO and ThO_2. Increasing the concentration of ThO_2 caused Young's modulus and strength to decrease; the observed values for Young's modulus agreed closely with those predicted for $BeO-ThO_2$ dispersions using Hashin and Shtrikman's method. It was concluded that the strength of $BeO-ThO_2$ dispersions is controlled by the strength of the weak ThO_2 particles unless the particle size is restricted to less than 5 μm. (BBB)

16650 ADHESIVE STRENGTH OF PORCELAIN ENAMELS TO STEEL. Lefort, Henry G. (Clemson Univ., S. C.). 7p. (CONF-660505-14). DTIE. Gmelin, AED-CONF-66-103-19.

From American Ceramic Society Meeting, Washington, D. C.

Variables which affect adherence of porcelain enamels to low-carbon steels and stainless steel-303 are reported. (P.G.C.)

Structure and Phase Studies

16651 (BNWL-350) THE PSEUDO TERNARY SYSTEM $BeO-UO_2-PuO_2$. McNeilly, C. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Phase relations in the $BeO-PuO_2-UO_2$ ternary system were determined by metallography, x-ray diffraction analysis, and melting point determinations on sintered pellets. BeO did not form a ternary compound or solid solution with $(Pu,U)O_2$. Under conditions of no O_2 loss, the lowest solidus in the ternary system was that of $BeO-PuO_2$ binary (2135°C). If O_2 loss could occur, the lowest solidus would be about 2000°C. (P.C.H.)

16652 (KFK-433) FESTKOERPERCHEMISCHE UNTERSUCHUNGEN UEBER DIE SYSTEME $SeO_{1.5}-ZrO_2(HfO_2)$, $AmO_{1.5}-ZrO_2(HfO_2,ThO_2)-O_2$ UND $TiO_2-NpO_2(PuO_2)$. (Solid Chemical Investigations of the Systems $SeO_{1.5}-ZrO_2(HfO_2)$, $AmO_{1.5}-ZrO_2(HfO_2, ThO_2)-O_2$, and $TiO_2-NpO_2(PuO_2)$). Radzewitz, Hubert (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). July 1966. 53p. (In German). Dep. mn.

The pyrochlore type and the fluorite phases with 1:1 composition of the rare earth oxides with Zr and Hf oxides were prepared and the dependence of the homogeneity range of the pyrochlore phase on the composition and the reaction temperature was investigated. In the system $NdO_{1.5}-ZrO_2$(1300°C) the homogeneous cubic phase of the fluorite and pyrochlore type was obtained at 27 to 57 mol % $NdO_{1.5}$. The range of the homogeneous cubic phase of the fluorite and pyrochlore type extended in the $EuO_{1.5}-ZrO_2$ (1300°C) from 18 to 71 mol % $EuO_{1.5}$. In the system $HoO_{1.5}-ZrO_2$ (1300°C) a homogeneous phase of the fluorite type was detected in the range from 8 to 72 mol % $HoO_{1.5}$. In the system $AmO_{1.5}-ZrO_2$ a cubic phase was observed at 1200°C from 35 to 55 mol % $AmO_{1.5}$. The homogeneous cubic phase of the pyrochlore type was reached in the $NbO_{1.5}-HfO_2$(1500°C) at 45 to 55 mol % $NbO_{1.5}$. In the system $EuO_{1.5}-HfO_2$(1500°C) a homogeneous cubic phase was established from 20 to 72 mol % $EuO_{1.5}$. This phase consisted of the fluorite and pyrochlore type. On the other hand in the system $HoO_{1.5}-HfO_2$(1500°C) from 15 to 71 mol % $HoO_{1.5}$ only the fluorite phase was observed. In the system $AmO_{1.5}-HfO_2$(1400°C) the range of the homogeneous cubic phases lay between 45 and 55 mol % $AmO_{1.5}$. At 1,480°C ThO_2 took a maximum of 48 mol % $LaO_{1.5}$. The upper solubility limit for $NbO_{1.5}$(1500°C) and $AmO_{1.5}$(1300°C) was determined as 50 mol %. O_2 vacancies occurred in these systems. In the system AmO_2-ZrO_2(1200 and 1400°C) there was a continuous miscibility of both oxides over 17 mol % AmO_2. In the system AmO_2-ThO_2 it was established that AmO_2 and ThO_2 mixed continuously with each other with linear changes of the lattice constants. In the system ThO_2-TiO_2 the formation of $ThTi_2O_6$ with two allotropic modifications was confirmed at 1000 and 1400°C. The high-temperature form β-$ThTi_2O_6$ was identified as monoclinic. In the analogous system NpO_2-TiO_2 the isotype compound $NpTi_2O_6$ was prepared and it had a monoclinic structure. A corresponding Pu compound could not be obtained. (tr-auth)

16653 THE STRUCTURE OF THE $SrO-ZrO_2$ SYSTEM. Tarnopol'skaya, R. A.; Gul'ko, N. V. Dokl. Akad. Nauk SSSR, 170: 1140-2(Oct. 11, 1966). (In Russian).

The $SrO-ZrO_2$ system has been restudied to check the existence of the previously reported Sr_2ZrO_4 compound and to plot the phase diagram of the system. Microscopic, x-ray, and chemical analyses of the annealed samples of various $SrO:ZrO_2$ compositions confirmed the existence of two compounds within the system, one of them $SrZrO_3$. The sample of a composition corresponding to Sr_2ZrO_4 was found to contain $Sr_5Zr_3O_{11}$ and free SrO. The newly detected $Sr_5Zr_3O_{11}$ was synthesized from the oxides at 1300 to 1500°C and $SrZrO_3$ was formed at 1200 to 1400°C. The compound $Sr_5Zr_3O_{11}$ melts incongruently at ~2200°C yielding $SrZrO_3$. Physical properties of $Sr_5Zr_3O_{11}$ were determined. The experimental fusibility data of various $SrO:ZrO_2$ compositions differed substantially with earlier data. An approximate phase diagram of the $SrO-ZrO_2$ system was established, which exhibits two eutectic points: 2100°C and 2270°C, which correspond approximately to 80% SrO and 26% SrO, respectively. Formation of solid solutions in the system was not observed. (ATD)

16654 SUBSOLIDUS STRUCTURE AND FUSIBILITY DIAGRAM OF THE $SrO-Al_2O_3-ZrO_2$ SYSTEM. Tarnopol'skaya, R. A.; Gul'ko, N. V. (Scientific-Research Inst. of Refractory Materials, Kharkov). Dokl. Akad. Nauk SSSR, 170: 1380-2 (Oct. 21, 1966). (In Russian).

The subsolidus structure of the $SrO-Al_2O_3-ZrO_2$ system was studied by microscopic and x-ray methods on sintered samples at 1600 to 2000°C. The triangulation of the system was performed and is shown. Judging from the lack of change in the optical and x-ray constants of the compounds formed, no appreciable concentrations of ternary solid solutions are formed in the system. The fusibility curve of the system is also shown. The most fusible eutectic is located close to the eutectic of the binary system $Sr_3Al_2O_6-SrAl_2O_4$ and melts at about 1500°C. It was found that the $SrO-Al_2O_3-ZrO_2$ system contains a broad range of compositions suitable for the preparation of refractories with service temperatures up to 1600°. (ATD)

16655 METALLOGRAPHIC EVIDENCE FOR A MARTENSITIC TRANSFORMATION IN U_3Si. Ambler, J. F. R. (Atomic

Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 22: 112-14(1967).

When a sample of U_3Si, which was cooled from above 765°C, was mechanically polished and etched, the grain structure revealed was equiaxed, not martensitic. (M.C.G.)

16656 ELECTRON-DIFFRACTION INVESTIGATIONS ON THE STRATIFICATION OF OXYGEN ATOMS IN NIOBIUM AND TANTALUM (STRUCTURE OF SUBOXIDES). Steeb, S.; Renner, J. (Max-Planck-Institut fur Metallforschung, Stuttgart). Metall, 21: 93-7(Feb. 1967). (In German).

Electrolytically thinned single crystalline foils of Ta and Nb were gassed with O_2 at an O_2 partial pressure of 5×10^{-4} torr at temperatures between 200 and 600°C for periods up to 24 hrs in an electron diffraction apparatus. The suboxide phases in single-crystal form were formed. The lattice dimensions of all these phases and the atomic distribution in the elementary cells of NbO_y, TaO_y, and TaO_z are given. The empirical numerical formulas are given as Nb_4O, $Ta_{32}O_9$, and Ta_2O. The elementary cells of all Nb and Ta suboxides are supercells and are composed of elementary cells of Nb or Ta metal. (tr-auth).

16657 SINGLE CRYSTALS OF THE TERNARY COMPOUNDS TiCuSi AND ZrCuSi. Nickl, J.; Sprenger, H. (Univ., Munich). Naturwissenschaften, 54: 18(Jan. 1967). (In German).

In melt on studies of the systems Ti–Cu–Si and Zr–Cu–Si long needles precipitated at high Cu concentrations; they were identified as single crystals with the composition TiCuSi or ZrCuSi. Some chemical properties of the compounds were determined and the orthorhombic unit cell for both compounds was found. (J.S.R.)

16658 INVERSION TWIN: PROTOTYPE IN BERYLLIUM OXIDE. Austerman, Stanley B.; Gehman, William G. (Atomics International, Canoga Park, Calif.). J. Mater. Sci., 1: 249-60 (Aug. 1966).

Evidence for the existence of inversion twins in abundance and on a macroscale as they commonly occur in BeO is described in detail. The inversion twin is an uncommon fault that potentially can be found in the wurtzite- and sphalerite-type crystal structures and related rhombohedral structures, all of which are hemimorphic and possess a polar axis parallel to the c-axis. The twin structure involves exact inversion of the sense of polarity across a transition region (boundary) of variable orientation and complexity. Existence and geometry of the twin is evidenced from crystal morphology and chemical and mechanical properties. It is suggested that the twin boundary may be stabilized and its energy lowered by the presence of aliovalent impurities along the boundary. Relation of the inversion twin to other types of faults is considered briefly. Previous discussions and presentations of new data in up-to-date assessment of the inversion twin are reviewed. (BBB)

Radiation Effects

Refer also to abstract 15931.

16659 EJECTION OF URANIUM ATOMS FROM SINTERED UO_2. Rogers, M. D. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 22: 103-5(1967). (AERE-M-1818).

Ejection of material from the surface of sintered UO_2 pellets by fission fragments was studied. It was found that about 110 uranium atoms are ejected for an average fission fragment leaving the surface. This is assumed to be due to small grains present. About 4.5 atoms per fission fragment is ascribed to "knock-ons" caused by hard-sphere collisions. (M.C.G.)

16660 SWEEPING OF BUBBLES BY GRAIN BOUNDARIES IN IRRADIATED UC. Macdonald, R. D. (Atomic Energy of Canada Ltd., Chalk River, Ontario). J. Nucl. Mater., 22: 109-11 (1967).

During the post-irradiation examination of an arc-cast UC specimen it was observed that the smallest bubbles remain attached to a moving grain boundary and that larger bubbles are left behind. A value for the activation energy for surface diffusion in UC was calculated. (M.C.G.)

16661 ON THE MICROSTRUCTURE OF UO_2 PELLETS IRRADIATED AT HIGH TEMPERATURE. Taketani, Kiyoaki; Ichikawa, Michio (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 1-10(Jan. 1967).

The microstructure of sintered UO_2 pellets irradiated at high temperature in the GETR were studied. Two groups of UO_2 pellets prepared from the same lot were irradiated under similar thermal conditions for different periods. The effects of burnup on the microstructure of the two groups were studied. An extensive development of columnar grains with lenticular voids were observed in the pellets from the lower burnup group, while those from the higher burnup group had large columnar grains characterized by many radial cracks. Detailed discussion is given. Autoradiographic techniques were also applied on the specimens to examine the microscopic structure. No appreciable migration of the fission products was detected. (auth)

16662 DIMENSIONAL CHANGES IN GRAPHITE IRRADIATED BETWEEN 500° AND 1100°C. Price, R. J.; Bokros, J. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Carbon, 5: 73-84(Feb. 1967). (GA-6854).

Two previously proposed quantitative models for the radioinduced dimensional changes in polycrystalline graphite treated the material as containing a single crystalline phase. One model was based on thermodynamic relationships and the other was derived by averaging the contributions of the individual crystallites. A third model emphasized the effects of small quantities of a second, less crystalline phase, but this model has not been expressed analytically. Measurements of dimensional changes in radial, circumferential, and longitudinal samples from an extruded graphite tube irradiated to exposures between 1.5 and 2.4×10^{21} nvt (E > 0.18 MeV) at temperatures between 540 and 1060°C were compared with the relationships predicted by the two quantitative models. It was found that the data agreed best with the single-phase thermodynamic model. (auth)

16663 VALUE OF A SILICON CARBIDE BARRIER IN HTR FUELS. de Nordwall, H. J.; Sayers, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). 31p. (CONF-661003-15). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

Results of experiments to determine the performance of SiC as a fission product retaining barrier in reactor fuels are reported. Comparison is made between fission product retention of SiC coated particles and pyrocarbon coatings. Techniques for coating fuel particles with SiC and for fabrication of SiC-matrix fuels are discussed. Other topics covered include fission product release at very low burn-up, metallurgical examination of high burn-up particles, migration of fissile material, and fission product retention in high-temperature reactor fuel elements. (P.G.C.)

16664 MICROSCOPIC AND AUTORADIOGRAPHIC STUDY OF HIGHLY RATED UO_2 NUCLEAR FUEL ELEMENTS. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). 4p. (CONF-660824-1). DTIE. Gmelin, AED-CONF-66-260-1.

From 5th Conference of Metallurgists, Toronto.

A summary of results of microscopic and autoradiographic examination of irradiated UO_2 fuel elements is presented. (P.G.C.)

16665 NEW MODEL FOR GAS RELEASE FROM IRRADIATED CERAMICS. de Bruin, H. J.; Kairaitis, D. 30p. (CONF-660606-55). DTIE. Gmelin, AED-CONF-66-203-117.

From American Nuclear Society Meeting, Denver.

Kinetics of He diffusion and release from irradiated BeO are shown by charts and in space-models based on time, temperature, and diffusion coefficients. Details of techniques and apparatus used to measure He release are described. (P.G.C.)

16666 RADIATION PERFORMANCE OF PLUTONIUM–URANIUM MONOCARBIDE FAST REACTOR FUELS. Bradbury, B. T.; Frost, B. R. T. (Atomic Energy Research Establishment, Harwell, Eng.). 30p. (CONF-661003-14). DTIE.

From AIME Nuclear Metallurgy Symposium on High Temperature Nuclear Fuels, Delavan, Wis.

Miniature PuC–UC fuel elements, 1-in. to 4-in. long and 0.1-in. to 0.25-in. dia, were irradiated in a thermal materials testing reactor at Harwell and in the Dounreay Fast Reactor (DFR). The objective was to establish the level of fission gas release from materials of differing compositions and densities. Results from fourteen elements showed that the level of gas release was around 1.0%, at 5% burnup of heavy atoms and a center temperature of about 1200°C, and at 10% burnup for a center temperature below 900°C. The restraint exercised by the cladding in all these experiments was sufficiently high to prevent significant fuel swelling. (auth)

Plastics and Other Materials

Refer also to abstracts 16588 and 16629.

16667 (BMI-X-10187) HEAT-RESISTANT CONCRETE FOR PRESTRESSED-CONCRETE-PRESSURE-VESSEL (PCPV) REACTORS. Quarterly Progress Report, October–December 1966. Fondriest, F. Frederick; Snyder, M. Jack (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1967. Contract W-7405-eng-92. 8p. (EURAEC-1808). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Several concrete mix designs were evaluated and final selections were made of those to be used. Chemical properties of the aggregates and cement were also determined. Numerous specimens were made to evaluate the moisture content of the concrete under various conditions of temperature and humidity. Trial specimens for evaluating the procedures to be used in the moisture migration studies were made and the final procedures are being formulated. Several moisture-seal coatings were evaluated and a final selection will soon be made. The design and selection of other test equipment is in progress. (auth)

16668 (NYO-2024-10) RADIATION DAMAGE STUDIES IN SOLIDS USING THE TECHNIQUES OF ELECTRON SPIN RESONANCE AND NUCLEAR MAGNETIC RESONANCE. Annual Progress Report, May 1, 1966–April 30, 1967. Bray, P. J. (Brown Univ., Providence, R. I. Dept. of Physics). Feb. 24, 1967. Contract AT(30-1)-2024. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

ESR studies of lithium borate glasses and polycrystalline compounds γ-irradiated at 77°K led to the postulation of an entirely new spin Hamiltonian for the "5-line" spectrum commonly observed in many irradiated boron-containing glasses. By means of a computer program, the experimental spectrum was successfully simulated on the basis of the new Hamiltonian; thus, the proposed model is considered to be verified. ESR studies of lithium borate glasses and compounds doped with divalent manganese supplemented the radiation damage studies described above. Accurate measures of spin-Hamiltonian parameters for Mn^{2+} in the $Li_2O \cdot 4B_2O_3$ compound were made, and it was demonstrated that the manganese sites in the latter compound are probably similar to some of the sites occurring in the glasses. Extensive efforts were devoted to the study of γ-irradiated niobate and titanate glasses and several new defect centers were identified; among these are Nb^{5+}-e, Nb-O·, Ti^{4+}-e, and Ti-O· centers. Several series of alkali germanate glasses were irradiated under various conditions and examined by ESR techniques. The g values and intensities of the various induced resonances are being studied as functions of glass composition. Attempts are being made to correlate these results with structural changes postulated on the basis of other evidence. Investigations of an interesting class of paramagnetic peroxyborate materials were pursued. Five types of paramagnetic centers traceable to some form of oxygen were identified, including RO· and RO_2· radicals, O_3^-, O_2^-, and O_2 molecules. Here, R is taken to be a four-coordinated boron. The feasibility of using divalent copper as an ESR "probe" of the structure of glasses was demonstrated. A series of $ZnSO_4-K_2SO_4-ZnCl_2-KCl$ glasses doped with Cu^{2+} are under investigation to determine the possible existence of complex heteroionic compounds in melts of these salts. (auth)

16669 THE EFFECT OF NEUTRON IRRADIATION ON SOME MECHANICAL PROPERTIES OF DIAMOND. PART I. ABRASION HARDNESS AND CLEAVAGE. Wilks, E. M. (Clarendon Lab., Oxford). Ind. Diamond Rev., 27: 110-15(Mar. 1967).

In studies using fast neutrons of energy up to 10 MeV (Pluto reactor at AERE, Harwell) it was found that very large doses (above about $10^{19} n_f/cm^2$) were required to produce any effect on the abrasion hardness and cleavage properties; this resulted in the specimens becoming black and opaque. The temperature of the specimens did not exceed 50°C, so that there was little or no annealing during irradiation. In general, reduction in hardness was small, although the decrease appeared much larger when measurements were made using loose diamond powder and in a hard direction. Changes were larger on the octahedron face than on the dodecahedron face; they were similar for cube and dodecahedron faces. Results can be explained on the basis that wear during grinding and polishing proceeds by microscopic cleavage processes. Hardness differences arise because it is easier to remove fragments by cleavage in some directions than in others. The effect of fast-neutron irradiation is to reduce the binding properties of the lattice, causing readier cleavage. The curvature and orientation of each surface, the complexity of each surface as shown by the number of large cleavage steps and discontinuities and the "matching" of opposite pairs of surfaces were studied. In annealing experiments it was found that although the abrasion hardness could be partly restored by heat treatment, the cleavage characteristics were scarcely affected. (UK)

16670 SOME CREEP EFFECTS IN STRESS ANALYSIS WITH PARTICULAR REFERENCE TO CONCRETE PRESSURE VESSELS. Zienkiewicz, O. C.; Watson, Margaret (Univ. of Wales, Swansea). Nucl. Eng. Design, 4: 406-12(Nov. 1966).

A description of a general process of stress analysis for materials of linear visco-elastic nature using an integral formulation of the visco-elastic properties is presented. The full solution is accomplished in a step-by-step manner using time intervals during which the stresses are taken to remain constant. The change of the creep strain taking place during such a time interval leads to an incompatibility which is corrected by an elastic solution at the end of each interval. The elastic solution at any stage is accomplished by the use of the finite element method. Computational problems are discussed, and the application of the method to the visco-elastic analysis of concrete pressure vessels is outlined. (auth)

16671 A DETERMINATION OF THE FRACTURE TOUGHNESS OF EGCR-TYPE AGOT GRAPHITE. Corum, J. M. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Nucl. Mater., 22: 41-54(1967). (ORNL-P-2675).

A step was taken towards the application of fracture mechanics concepts to the design of graphite components to prevent brittle fracture. Tests were performed on notched bend specimens of EGCR-type AGOT graphite, and the results were used to determine values of G_c, the critical rate of strain energy release for fracture. Relationships established both by the theory of elasticity and by experimental compliance testing were used for determining the G_c values. The critical rate of strain-energy release for specimens parallel to the axis of extrusion of the material was found to be approximately 0.39 in.-lb/in.^{2} (6.8×10^4 erg/cm^2), and for specimens oriented transverse to the axis of extrusion the value was approximately 0.29 in.-lb/in.^{2} (5.1×10^4 erg/cm^2). The G_c values based on the analytical and compliance analysis relations were in good agreement. This study indicates that the concept of a critical strain-energy release rate being a condition for rapid crack propagation applies to graphite. (auth)

16672 IDENTIFICATION AND SOME PHYSICO-CHEMICAL CONSEQUENCES OF NON-BASAL EDGE AND SCREW DISLOCATIONS IN GRAPHITE. Roscoe, C.; Thomas, J. M. (Univ. Coll. of North Wales, Bangor). Proc. Roy. Soc. (London), Ser. A, 297: 397-407(Mar. 7, 1967).

An optical microscope study of the basal faces of partially oxidized (by oxygen) single-crystal flakes of natural graphite was carried out. It proved possible to distinguish the sites of emergence of non-basal edge and non-basal screw dislocations by utilizing both the extreme reactivity of such sites in the presence of added Mo or B, and the fact that cleavage, under certain conditions, can reveal screw dislocations. Non-basal dislocations often form small-angle boundaries (and possibly walls arising from polygonization) thus converting a single crystal into a mosaic. A method of analyzing the dislocations constituting such boundaries is described. Values of the ratio of the rate of oxidation along the c axis to that along the basal planes, $R_{c/a}$ (a measure of the kinetic anisotropy), were estimated. At dislocation cores containing added Mo, $R_{c/a}$ can be greater by a factor of at least 10^{15} than at "ordinary" sites in the basal planes. The actual rate of oxidation at the deliberately contaminated cores is approximately 5×10^{-3} g cm^{-2} s^{-1} at 800°C. From cleavage experiments, two main conclusions were drawn. First, internal oxidation may occur at dislocation cores within the bulk of a so-called single crystal, it being postulated that access by the oxidizing gas is gained via microcracks and voids running parallel to the basal plane and via basal-plane intercrystallite boundaries. Secondly, when stresses are applied along the c axis, extensive deformation (resulting in lack of correspondence of cleavage steps on pairs of separated cleavage faces) may occur during the act of cleavage. It was also concluded that the fracture surface energies for $\{10\bar{1}1\}$ and $\{11\bar{2}1\}$ faces are approximately equal. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 16859, 16956, and 17093.

16673 SPECTROPHOTOMETRIC OBSERVATIONS OF N HER 1963. I. THE NEBULAR STAGE. Bartash, T. M.; Boyarchuk, A. A. Izv. Krym. Astrofiz. Observ., 33: 173-85(1965). (In Russian).

Altogether, 40 lines in the 6500 to 3500 Å spectral region were identified. Their relative intensities and that of the continuous spectrum are determined. The variations of the relative intensities of different lines are studied. The electron temperature T_e = 19,000° is derived from observations made during spring–summer, and T_e = 15,000° from those made in the autumn. It is found that the hydrogen and helium abundances in the envelope of the nova is less by almost one order than in the sun, if it is assumed that the nitrogen and oxygen abundances are normal. (auth)

16674 REMARKS ON THE CHEMICAL COMPOSITION OF Z AND. Boyarchuk, A. A. Izv. Krym. Astrofiz. Observ., 33: 186-94(1965). (In Russian).

It is found that the Z And envelope has a hydrogen abundance excess of about a factor of 5 as compared to the elements of the oxygen group. The He, N, and O relative abundances do not differ, within the limits of precision, from those in NGC 7027. It is shown that there are appreciable nonuniformities in the envelope and therefore determinations of the atom abundances from forbidden lines are unreliable. (auth)

16675 PHOTOMETRIC AND COLORIMETRIC CHARACTERISTICS OF ERUPTIVE STARS. II. Gershberg, R. E. Izv. Krym. Astrofiz. Observ., 33: 206-14(1965). (In Russian).

The present paper is a continuation of the analysis of photometric and colorimetric characteristics of eruptive stars within the framework of the nebular model, in which the radiation of these objects is assumed to be the summed radiation of the system star plus hot gas of small optical thickness. The gaseous and stellar parameters are computed, these being necessary for the determination of the colors and brightness of systems consisting of different-type stars and gaseous bodies at different physical conditions. A comparison is made of the observed and theoretical tracks of the flare of H II 1306 in the two-color diagram and that of EV Lac in the color–magnitude diagram. The ratios of increasing the colors and brightness, at brightness variations of small amplitude, due to the appearance of an additional radiation source, are given. (auth)

16676 PHOTOELECTRIC OBSERVATIONS OF FLARE STARS. III. Chugainov, P. F. Izv. Krym. Astrofiz. Observ., 33: 215-25(1965). (In Russian).

Results are given of observations of the flare stars EV Lac and AD Leo made at the Crimean Astrophysical Observatory during 1960 to 1963. In some cases a "pre-flare" phenomenon was observed: several minutes before flare commencement a slight brightness increase was noted. The (B–V) variation curves of the flare were obtained for 4 flares. At maximum brightness of the flare (B–V) ≈ –0.2 to –0.3. Then a rapid reddening is observed to B–V ≈ +0.2. The total energy in the 3300- to 6000-Å wavelength region is found from 15 flares of EV Lac and is within the limits 10^{32} to 5×10^{33} ergs. (auth)

16677 AN INVESTIGATION OF THE PHYSICAL CONDITIONS IN THE ATMOSPHERES OF O STARS. Kumaigorodskaya, R. N. Izv. Krym. Astrofiz. Observ., 33: 242-65(1965). (In Russian).

The physical conditions in the atmospheres of 19 O4.5 to O9.5 type stars were analyzed on the basis of 170 spectrograms with a dispersion of 33 and 14 Å/mm. The behavior of the absorption lines in dependence on spectral type and luminosity was studied. A qualitative explanation is given of the observed peculiarities. The electron densities in the atmospheres of these stars were determined by two methods from the hydrogen spectrum. The possibility of constructing the curves of growth for O stars using He II lines is shown. The T_{ion} are found from the helium lines. It is shown that these temperatures do not characterize the atmosphere of the star as a whole, but are related to a layer with an optical thickness which varies with spectral type. Therefore, the T_{ion} obtained cannot be used as the main parameter of the whole atmosphere and as a scale of ionizational temperatures. The Zanstra temperatures found from the He II, N III, and C III emission lines are close to the effective temperatures. The turbulent velocities were determined from the 2^3P and 2^1P He I and He II lines for all the stars using the curves of growth. A qualitative explanation is given of their ratios and variation with spectral type. The velocities of macroturbulent motions derived from the He I and He II line profiles on the average exceed those found from the curves of growth by about a factor of 2 to 3. (auth)

16678 SUPERSONIC TURBULENCE IN SUPERGIANT ATMOSPHERES. Gollandskii, O. P. Izv. Krym. Astrofiz. Observ., 33: 266-72(1965). (In Russian).

The kinematic and magnetic viscosities and the corresponding Reynolds numbers Re and R_m were computed for B0.5–F0.1 supergiant atmospheres. The latter quantities permit a wide range of wave numbers (10^{-10} to 10^{-3} cm^{-1}) in which there can be an interval with a spectrum close to the Kolmogorov spectrum. The necessary condition for the existence of stationary supersonic turbulence is formulated. This condition is fulfilled for all the stars considered. (auth)

16679 ELECTRON DENSITIES IN ATMOSPHERES OF METALLIC-LINE STARS. Komarov, N. S. Izv. Krym. Astrofiz. Observ., 33: 273-8(1965). (In Russian).

The electron densities in the atmospheres of 29 A–F-type stars with quantitative spectral classification were found from the last resolved Balmer line (n_m) using the Inglis–Teller formula. Altogether, 107 spectrograms with a dispersion of 150 Å/mm at Hγ obtained with the 122-cm reflector of the Crimean Astrophysical Observatory were used. The method of determination of the number of the last resolved Balmer line by extrapolation of the relation between W and n to zero equivalent width is compared to the method of extrapolation of the relation between R_0 and n to zero central depth. The electron densities in atmospheres of metallic and nonmetallic stars do not differ on the average from the electron densities of normal MS stars of the same hydrogen spectral class. (auth)

16680 THEORY OF THE BLANKETING EFFECT. Buslavskii, V. G. Izv. Krym. Astrofiz. Observ., 33: 279-85(1965). (In Russian).

An exact solution has been obtained on the problem of the blanketing effect, assuming that the photosphere is a layer with optical thickness τ_0, the brightness coefficients of which are known. (auth)

16681 AN EVOLUTIONARY INTERPRETATION OF THE H–R DIAGRAM FOR HOT STARS. II. THE PERIOD–LUMINOSITY RELATION AND MASSES OF LONG-PERIOD CEPHEIDS. Kopylov, I. M. Izv. Krym. Astrofiz. Observ., 33: 286-300(1965). (In Russian).

The distance moduli of 7 galactic clusters with long-period Cepheid members were determined. Parameters of the initial MS obtained by the author and published photometric and spectral data were used. The individual absolute magnitudes of 15 Cepheids are derived and the period–luminosity relation found. The median M_{bol}, T_{eff}, and lg R are determined for these 15 Cepheids and for the whole class of Cepheids in the mean. The M_{bol} are within the limits $0^m.75$ to $6^m.0$, T_{eff} 6900° to 4900°, and R 9 to 200 solar radii. A comparison of the evolutionary tracks of B stars with the position of Cepheids in the (Sp, M_{bol}) diagram permits to estimate the masses of Cepheids (3 to 11 $M_\odot$) and to draw the conclusion that B1.0 to B6.5 stars on the initial MS can evolve into Cepheids. A comparison of the mass distribution function of Cepheids N(lgM) with the mass function of B stars ψ (lgM) allows some general conclusions on the probability of the setting in of pulsational instability of previous B stars and an estimate of the optimal mass of Cepheids (3.5 to 5.5 $M_\odot$). The lower limit of the life-time of stars with 4 to 5 $M_\odot$ as Cepheids is estimated as $t \sim 1$ to 4×10^7 years. (auth)

16682 ANOMALOUS REDDENING OF EARLY B TYPE STARS IN GALACTIC CLUSTERS. Raznik, R. M. Izv. Krym. Astrofiz. Observ., 33: 301-7(1965). (In Russian).

The anomalous reddening effect, i.e., increased color excesses E_{U-B} and E_{B-V} for B3–B0 type stars, was studied on the basis of data for 40 young clusters. The maximum deviation of E_{U-B} and E_{B-V} from the mean for each cluster was observed for the B0 subclass and was $\Delta E_{U-B} = 0^m.12$ and $\Delta E_{B-V} = 0^m.14$ in the mean for all of the clusters. It is not as yet clear whether O-type stars also show this increase in color excess. The anomalous reddening effect is more definitely pronounced for supergiants. (auth)

16683 STUDY OF THE ROTATION OF THE MAGNETIC FIELD WITH DEPTH IN THE SOLAR ATMOSPHERE. Severnyi, A. B. Izv. Krym. Astrofiz. Observ., 33: 3-33(1965). (In Russian).

A conclusion obtained earlier on the rotation of the polarization plane with depth in the solar atmosphere is verified. The recordings of the transverse field were made with a magnetograph in three lines of different intensity λλ 5302, 5250, and 4808, the recording in the initial line (usually λ 5250) being repeated in order to control the possible rotation of the polarization plane with time. The recordings and maps of the vector of transverse vibrations $\delta_\perp$ show a strong rotation effect from one line to another. In most cases the rotation effect of the vector $\delta_\perp$ with depth is observed in places where rotation does not vary with time. In places which show rotation with time this effect is in most cases of opposite direction to that which should be expected from the rotation effect with depth. Quantitatively, rotation with time is essentially smaller by several factors than rotation with depth which sometimes attains 70 to 80° at a depth of 100 km in the solar atmosphere. Two types of rotation with depth are described. (auth)

16684 STUDY OF THE MAGNETIC FIELD AND ELECTRIC CURRENTS OF UNIPOLAR SUNSPOTS. Severnyi, A. B. (Belorussian State Univ., USSR). Izv. Krym. Astrofiz. Observ., 33: 34-79(1965). (In Russian).

The transverse and longitudinal magnetic fields of several unipolar groups recorded with the Crimean solar magnetograph are studied. A method of calibration of the transverse field by comparison of magnetograph recordings with photographic measurements is proposed. It is noted that the vortical structure of the transverse field recorded in group 53 from July 8 to 18, 1962 is a rare phenomenon, the curvature fluctuations of spirals of the vortex reflect more probably hydrodynamic torsional oscillations. The unipolar spot field is concentrated mainly in ropes emerging from the spot. The appearance of strong transverse fields inside spots is again noted. The total field vector H and its inclination to the vertical γ are computed for two spot groups. An analysis of the run of γ and $|H|$ with distance from the spot center shows that these quantities vary more slowly than found at Mount Wilson and according to the Broxson law. The field disappears and becomes transversal at a distance comparable to the spot diameter and further. In the penumbra and outside the spot the fields are mainly transversal (the average inclination γ at the outer boundary is 70°). The variation of $|H|$ with distance is in good agreement with that found for a dipole of length L diameter of the spot and submerged at a depth L beneath the photosphere. Special attention is paid to the computation and investigation of the system of vertical electric currents (rot H). The structure of the current pattern is very peculiar indicating the presence of current loops around radial ropes of the field. The fine structure of the currents connected with rapid rotation of the transversal field and contacts of strong currents ($\sim 10^{11}$ A) of opposite directions is observed. The areas occupied by opposite currents are found to be practically equal. It is concluded that the current system of a unipolar spot is probably a system of stationary currents. Maps of longitudinal field gradients ($\partial Hz/\partial z$) show a contact in the spot of regions with gradients of opposite sign. This is probably evidence of the nonuniformity of the field in the spot. (auth)

16685 COMPUTATION OF SUNSPOT MAGNETIC FIELDS. Godovnikov, N. V.; Smirnova, E. P. Izv. Krym. Astrofiz. Observ., 33: 86-91(1965). (In Russian).

An attempt is made to construct a sunspot model by means of elongated magnetic tubes. Charts of the field of such a dipole system and the magnetic field gradient near the zero point are computed. The results are of the same order as those obtained from models. (auth)

16686 MAGNETIC FIELDS AND FINE STRUCTURE IN AN ACTIVE REGION. Tsap, T. T. Izv. Krym. Astrofiz. Observ., 33: 92-9(1965). (In Russian).

The orientation of fine chromospheric structure in Hα and the structure of the penumbra in integral light relative to transverse magnetic fields recorded at photospheric level are studied. Good agreement is found between the orientation of fine chromospheric structure and the direction of transverse magnetic fields. The accordance between the orientation penumbra filamentary structure observed in integral light and transverse magnetic fields is much less satisfactory than for the chromosphere. (auth)

16687 TEMPORARY VARIATIONS OF THE TRANSVERSE MAGNETIC FIELD STRUCTURE IN SPOT GROUPS AND OPTICAL PHENOMENA. Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 33: 100-10(1965). (In Russian).

The following conclusions are obtained from a complex study of the structure of the transverse magnetic field, photoheliograms and Hα films of two spot groups (Sept. 2–8, 1961 and July 11–13, 1962): (1) Irregular rotation of spots leading to the winding of the magnetic field in a direction opposite to that of spot rotation is sometimes observed. (2) The winding of the magnetic field by a rotating spot is evidence in favor of a magnetic field "frozen in" the medium at photospheric level. (3) There is a close correlation between the frequency of appearance of surges and the rate of winding of a spot magnetic field. (4) The rotation of a spot can lead to its sausage instability. The resulting magnetic field gradients can accelerate gas with a density of even $\rho \gtrsim 10^{-11}$ g/cm³ up to hundreds of kilometers per second. (auth)

16688 THEORY OF FORMATION OF ABSORPTION LINES IN A MAGNETIC FIELD. Rachkovskii, D. N. Izv. Krym. Astrofiz. Observ., 33: 111-17(1965). (In Russian).

Results are given of numerical computations of polarized radiation in lines with a nonsplit upper level. True absorption and radiative scattering in the line are taken into account. Very large discordances are noted between the characteristics of polarized radiation computed according to Unno's theory. It is concluded that at the center of the solar disk it is apparently not necessary to take radiative scattering into account. (auth)

16689 THE DEVELOPMENT OF CHROMOSPHERIC FLARE SPECTRA AT FLASH PHASE (FLARE OF 26 SEPTEMBER 1963). Banin, V. G. Izv. Krym. Astrofiz. Observ., 33: 118-37(1965). (In Russian).

The results of a study of the development of the Sept. 26, 1963 flare spectrum at flash phase are given. Observational facts and considerations do not confirm the explanation of asymmetry in disk flares. It is shown that "red" asymmetry is due to a strengthening of the longwave wing of the line as a result of superposition of additional emission. This effect is due to the inflow of luminescent matter into the flare. The brightening of metallic lines is followed. Lines with an upper level excitation potential of ~5.5 eV brighten most rapidly, and those with ~3.3 eV somewhat more slowly. As compared to these cases the brightening of other lines is considerably slower. Lines strengthened in the chromosphere brighten on the whole more rapidly than non-strengthened lines. There are reasons to suppose that line brightening is connected also with the process of propagation of the flare in the solar atmosphere. (auth)

16690 AN INVESTIGATION OF "MOUSTACHES" AND EJECTIONS IN CONNECTION WITH THE DEVELOPMENT OF SPOT GROUPS. Koval, A. N. Izv. Krym. Astrofiz. Observ., 33: 138-50(1965). (In Russian).

The study of "moustache" phenomena and motions in the region of "moustaches" was continued. On the basis of a large number of spectrograms of "moustaches" and continuous visual observations in Hα with the spectrograph of the tower solar telescope it was found that the "moustache" phenomenon is intimately connected with the development of a spot group: "moustaches" accompany the process of formation, development and decay of spots. The presence or absence of motions in the region of "moustaches" depends on the stage of development of the spot group. From visual observations it follows that ejections often precede the formation of spots and flocculi and are observed in large numbers in the first period of existence of a group. Hydrogen line profiles in "moustaches" were studied. In the majority of cases the extension of the blue and red wings of "moustaches" is the same. The brightness of the blue and red wings differs in most cases. The blue wing is brighter in 52% of the cases, the red in 33% and the brightness is the same in 15% of the cases. From the observed motions in "moustache" regions it is concluded that the asymmetry is apparently connected with a weakening of "moustache" emission in one of the wings by absorption ejections. (auth)

16691 SMALL EFFECTS OF FLARES IN COSMIC RAYS AND PROTON FLARES. Vladimirskii, B. M. Izv. Krym. Astrofiz. Observ., 33: 151-5(1965). (In Russian).

Arguments are given in favor of the solar origin of the stream of particles with energies < 200 MeV. There is no qualitative difference between the small and large effects of flares in cosmic rays and the differentiation of a special class of "proton" flares is physically unjustified. (auth)

16692 CONNECTION BETWEEN SOLAR COSMIC RAY INTENSITY INCREASE AND PARAMETERS OF THE CORRESPONDING CORPUSCULAR STREAM. Pankratov, A. K. Izv. Krym. Astrofiz. Observ., 33: 156-9(1965). (In Russian).

A very close correlation was found between the stream of solar cosmic rays and the amplitude of the Forbush-type decrease. (auth)

16693 TIME VARIATIONS OF THE X-RAY SPECTRUM OF SOLAR FLARES. Neshpor, Yu. I. Izv. Krym. Astrofiz. Observ., 34: 313-18(1965). (In Russian).

A method is proposed for the determination of the time variations of x-ray intensity and character of the x-ray spectrum

changes from data on SIDs recorded by ground apparatus. It is shown that during the solar flare of November 23, 1957, the x-ray spectrum varied with time. (auth)

16694 A SPECTROPHOTOMETRIC STUDY OF AX PER. Boyarchuk, A. A. Izv. Krym. Astrofiz. Observ., 35: 8-10(1966). (In Russian).

It is found that the helium-to-hydrogen abundance ratio is 0.36. It is shown that the envelope has a high electron density $n_e > 10^7$. (auth)

16695 ELECTRON DENSITIES IN THE ATMOSPHERES OF HOT STARS. II. Kopylov, I. M. Izv. Krym. Astrofiz. Observ., 35: 11-33(1966). (In Russian).

It was shown previously that essential changes are needed in Unsold's method for the determination of electron densities in the atmospheres of early-type stars, as its two variants can give density values differing by a factor of 20 to 30. Unsold's method is analyzed in detail and the necessary modification proposed. (auth)

16696 INVESTIGATION OF THE TURBULENCE SPECTRUM IN APPLICATION TO STELLAR ATMOSPHERES. Gollandskii, O. P.; Chub, A. T. Izv. Krym. Astrofiz. Observ., 35: 34-44 (1966). (In Russian).

The solution of the spectral equation of isotropic turbulence taking in account the dissipation of energy of shock waves as applied to conditions in B–F supergiant atmospheres is investigated. It is shown that in the region of wave numbers, to which correspond motions with Mach numbers $M_k \ll 1$, but where the influence of viscosity is not essential, the spectrum is close to the Kolmogorov. In the region of wave numbers to which correspond motions with $M_k > 1$, the spectrum is steeper than the Kolmogorov, but not steeper than k^{-3}. (auth)

16697 BALMER DECREMENT IN THE SPECTRA OF MOVING MEDIUMS. Boyarchuk, A. A. Izv. Krym. Astrofiz. Observ., 35: 45-80(1966). (In Russian).

The population of levels, the probability of quanta exit, and the relative Balmer line intensities were computed on the basis of the theory of moving envelopes. The arguments are given for a wide range of values of the electron temperature T_e, the radiative stellar temperature $T_{\text{зв}}$, the dilution coefficient w, and the probability of L_α-quanta exit β_{21}^0. The first thirty levels were considered in the solution, a correction being applied for the remaining levels. It is found that there is a strong dependence of the Balmer decrement on β_{21}^0. With decreasing β_{21}^0, the Balmer decrement is at first steep and then becomes flatter. The Balmer decrement also depends on $T_{\text{зв}}$ and w and only slightly on T_e. The observed and computed decrements for a Be star are in satisfactory agreement. (auth)

16698 THEORY OF RADIATIVE TRANSFER IN STELLAR PHOTOSPHERES. Buslavskii, V. G. Izv. Krym. Astrofiz. Observ., 35: 81-6(1966). (In Russian).

It is shown that all the results of the theory of radiative transfer in stellar photospheres, based on the assumption that the absorption coefficient in the photosphere does not depend on frequency, can be obtained by application of Laplace transformations to the main equations of the theory. (auth)

16699 PHYSICAL CONDITIONS IN THE NUCLEUS OF THE GALAXY NGC 1275. Dibai, E. A.; Pronik, V. I. Izv. Krym. Astrofiz. Observ., 35: 87-96(1966). (In Russian).

The results of a spectral study of the nucleus of the radio galaxy NGC 1275 are given. The data on spectral line intensities and profiles lead to the assumption of the presence in the nucleus of two subsystems of gas with different values of physical parameters and velocity dispersion. The following are found for each subsystem: $n_e \approx 3 \cdot 10^8$ cm^{-3}, $T_e \approx 16{,}000$°K, v = ±2000 km/sec, M ≈ 35 $M_\odot$ for the first and $n_e \approx 4 \cdot 10^3$ cm^{-3}, $T_e = 12{,}000$°K, v = ±500 km/sec, M ≈ 10^4 $M_\odot$ for the second. Two models of gas distribution are discussed: (1) a spherical envelope which dissipates as the result of a strong explosion, and alternatively (2) a diffuse model. It is shown that the second model is the more probable. According to it, the dense elements of the gas (first subsystem) dissipate with a large velocity from a common center. As the gas expands, it decelerates and its density and temperature decrease. Thus the outflow of gas from the central regions of the nucleus leads to the formation of an outer subsystem. The characteristic lifetime of the gas in the first and second subsystems is correspondingly ~2×10^3 and 3×10^5 years. The ratio of the total mass of gas (~10^4 $M_\odot$) to the age of the outer subsystem permits the estimation of the average mass loss of the order of 0.03 $M_\odot$ per year. The possibility that the observed phenomenon is due to more or less regular supernovae outbursts in the nucleus is not excluded. (auth)

16700 INVESTIGATION OF THE GENERAL MAGNETIC FIELD OF THE SUN. Severnyi, A. B. Izv. Krym. Astrofiz. Observ., 35: 97-138(1966). (In Russian).

It is shown that conclusions on the character of the general magnetic field depend to a great degree on the resolving power of the magnetograph recordings: if at low resolving power (50″, Babcock) the field may be coherent in the greater part of the polar region, at high resolving power it consists of numerous separate elements of different polarity, field strength, and length. With increasing resolving power, from 50″ to 2″, the field strength of separate elements can increase from 2 to 30–40 gauss, while the number of elements increases only by a factor of 1.5 to 2. (auth)

16701 SOME PECULIARITIES OF MOTIONS IN SINGLE SUNSPOTS. Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 35: 139-49(1966). (In Russian).

In 1963, photoelectric recordings of signals of the radial velocities and longitudinal magnetic fields of two single sunspots were obtained in the lines λ 5250 Å (g = 3), λ 5288.55 (g ≈ 1.0) and λ 5123.7 (g = 0). At all times along the diurnal parallel only one cross section, which passed through the spot center, was recorded. A change of sign in the velocities due to the Evershed effect was registered for one of the spots. As a result of the study of the data it was found that: (1) The velocity component along the line of sight disappeared when the spot was at a distance of 7 to 8° to the west of the central meridian (latitude –12° N). (2) The magnetic axis of the spot and the normal to the plane of the velocity vectors of the spot coincide and are inclined by 7° to 8° to the east of the normal to the solar surface. The velocity field in a spot is analyzed and it is noted that the difficulties in explaining the peculiarities of the Evershed effect can be overcome by assuming that the magnetic field rises to the surface of the sun during all the time of existence of the spot. (auth)

16702 DETERMINATION OF RADIAL VELOCITIES BY MEANS OF A MAGNETOGRAPH. Ikhsanov, R. N. Izv. Krym. Astrofiz. Observ., 35: 150-60(1966). (In Russian).

The degree of reliability of radial velocities obtained by means of a magnetograph is determined by comparison with photographically observed velocities. It is found that the radial velocities determined with a magnetograph can, in some cases, be erroneous. When two photomultipliers are used in the magnetograph a fictitious radial velocity appears if the brightness of the spectrum varies. At large values of magnetic splitting of the lines, the results of measurements of velocities can also be erroneous in some cases. This conclusion applies first of all to the line λ 5250.218. The error can be avoided if the radial velocities are determined from lines which are less sensitive to the magnetic field. In a sunspot both of the above factors distort the true radial velocity. (auth)

16703 PHOTOSPHERIC MAGNETIC FIELDS AND THE STRUCTURE OF THE UNDISTURBED CHROMOSPHERE. Tsap, T. T. Izv. Krym. Astrofiz. Observ., 35: 161-5(1966). (In Russian).

The brightness of clusters in the undisturbed chromosphere is compared with transversal magnetic fields recorded in the photospheric iron line λ 5250 Å. It is found that, on the average, the brightness of the clusters increases with increasing field strength. In about 74% of the total number of cases, a correlation is observed between the presence of a magnetic field in the photosphere and calcium emission in the chromosphere. (auth)

16704 CHANGES IN THE PHYSICAL STATE OF A SUNSPOT IN THE COURSE OF ITS DEVELOPMENT. Stepanyan, N. N. Izv. Krym. Astrofiz. Observ., 35: 166-76(1966). (In Russian).

Spectra of the leading spot were obtained during the whole period of development of the group (7 days). The spot area, magnetic field, brightness temperature at λ 6250 Å, and excitation temperature were determined for every day of observations. It is found that during the development of the spot, the brightness and excitation temperature difference decreases and, at the moment of area maximum and lowest temperature, is close to zero. After this the difference increases again. This smoothing of temperature is explained by a weakening of the influence of the photosphere during the growth of the spot and the formation of isothermal region in the spot. The possibilities of a rapid determination of excitation temperature from equivalent width variations of separate lines with a small excitation potential of the ground level are discussed. A method is proposed which enables a rapid determination of the excitation temperature from a comparison of the equivalent widths of four lines. The method is free from the influence of light scattering. However, the error of one determination exceeds that of the equivalent widths by a factor of 4. The proposed method is most suitable for application to photoelectric observations. (auth)

16705 ABSORPTION LINES SUITABLE FOR THE DETERMINATION OF LIGHT SCATTERING IN SPECTROPHOTOMETRY OF SUNSPOTS. Guseinov, M. D. Izv. Krym. Astrofiz. Observ., 35: 177-8(1966). (In Russian).

A list of absorption lines is given, which is convenient for the determinations of light scattering and the deformation effect, caused by the image tremor according to Howard's method in spectrophotometry of sunspots. (auth)

16706 TEMPERATURE DISTRIBUTION IN A SUNSPOT. Buslavskii, V. G. Izv. Krym. Astrofiz. Observ., 35: 179-85 (1966). (In Russian).

A system of equations was obtained for the temperature distribution in a sunspot as a function of two variables: the optical depth τ at the spot center and the distance τ from the spot center. It is shown that the distribution depends on the radius of the spot and the ratio of the absorption coefficient in the spot center to that in the solar photosphere. (auth)

16707 A DETERMINATION OF THE SOLAR ABUNDANCE OF SEVERAL ELEMENTS USING THE SUNSPOT SPECTRA. III. THE INDIUM ABUNDANCE. Dubov, E. E.; Khromova, T. P. Izv. Krym. Astrofiz. Observ., 35: 186-9(1966). (In Russian).

The abundance of indium found from the sunspot spectra is: $\lg N_{In} = 0.75 \pm 0.2$ (taking, $\lg N_H = 12.0$). (auth)

16708 STRUCTURE OF STRONG CHROMOSPHERIC FLARES WITH HEIGHT. Banin, V. G. Izv. Krym. Astrofiz. Observ., 35: 190-203(1966). (In Russian).

A model of the structure of strong chromospheric flares with height in the solar atmosphere is proposed. The flare is represented as consisting of two loops which form, together, a figure 8. In the general case the 8 is oriented along the radius, the lower loop penetrating deeply into the base of the chromosphere and the top of the upper loop into the region of the upper chromosphere or lower corona. It is assumed that the structure and also the dynamics of the flare matter are determined by the magnetic field. Solar plasma condenses at the tops of the loops in bright clusters of small dimensions. In the following moment the clusters explode and the radiating matter flows along lines of force to the bases of the loops. At the initial parts of the trajectories, the velocities are approximately parallel to the solar surface, then the streams bend rapidly and the motion becomes close to radial. As the matter moves along its trajectories it gradually decelerates and finally stops. Regions of increased pressure are formed at the bases of the loops due to the action of the streams of matter. This leads to the contraction of the chromosphere and an increase of its emission. (auth)

16709 METHOD OF OBSERVATIONS OF SOLAR RADIO EMISSION AT 8 MM. Efanov, V. A.; Moiseev, I. G. Izv. Krym. Astrofiz. Observ., 34: 53-9(1965). (In Russian).

The radio telescope for observations at 8 mm is described. It has double-frequency modulation, which permits the exclusion of different forms of interference, and provides for a continuous control of the receiver amplification and the temperature of the compare channel. The solar radio emission flux variations at 8 mm, due to absorption in the Earth's atmosphere at variations of the visible height of the source, are discussed. (auth)

16710 ELECTROPHOTOMETRY OF SUPERGIANTS. Vitrichenko, E. A.; Semenyuk, I. Izv. Krym. Astrofiz. Observ., 34: 106-13(1965). (In Russian).

Electrophotometric observations of two supergiants χ^2 Ori (B2 Ia) and β Ori (B8 Ia) were made on a system close to the UBV. Light variations of an irregular character were detected for χ^2 Ori. The variations of the spectrophotometric gradient of this star can be explained by temperature variations of the order of 2000°. The variability of β Ori is confirmed. Evidently the character of the light curve has not changed during the last 19 years. Variability of λ Eri is suspected. (auth)

16711 SPECTROPHOTOMETRIC STUDY OF ρ CAS. Boyarchuk, M. E. Izv. Krym. Astrofiz Observ., 34: 136-50(1965). (In Russian).

As a result of a study of the spectroscopic parameters of ρ Cas, δ CMa, and γ Cyg atmospheres it was found that the atmosphere of the irregular variable ρ Cas resembles that of the brightest F8 Ia supergiants. An analysis of the metal content shows that in the atmosphere of ρ Cas the abundance of light elements is somewhat smaller and that of heavy elements greater than in the atmospheres of the supergiants δ CMa and γ Cyg. (auth)

16712 MICROTURBULENT MOTIONS IN ATMOSPHERES OF HOT STARS. I. Kopylov, I. M. Izv. Krym. Astrofiz. Observ., 34: 163-76(1965). (In Russian).

The microturbulent velocities v_t in the atmospheres of 68 O6–B5 type stars were determined by the curve of growth method using the N II, O II, Si II, Si III, and Si IV ion lines. The possible errors in the determination of v_t are analyzed. The relations between v_t and the absolute magnitude M_v, and v_t obtained according to the lines of each ion, are considered for six narrow intervals of spectral type. The turbulent velocities in the atmosphere increase with the luminosity of the star. The characteristic variations of v_t with spectral class are analyzed by qualitative manner. The curves of the relation between v_t and spectral class have distinct maxima, which are located at different spectral subclasses depending on the ions and luminosities considered. Such relations are due to: a) the increase of v_t with height in the stellar atmosphere and b) the variation of the effective optical depth of line formation of different ions within the atmosphere, which depends on spectral type. The theoretical estimates of the positions of the v_t maxima for different ions are in good agreement with the results obtained from the curve of growth analysis. (auth)

16713 AN INVESTIGATION OF HIGH VELOCITY EARLY TYPE STARS ("RUNAWAY OB STARS"). Vitrichenko, E. A.; Gershberg, R. E.; Metik, L. P. Izv. Krym. Astrofiz. Observ., 34: 193-226(1965). (In Russian).

Stars are attributed to runaway objects if the absolute value of one of the components of space velocity θ, π, or ξ is larger than the dispersion by a factor of three, $3\sigma_{\theta,\pi,\xi}$, or if the absolute value of peculiar radial velocity $\geq$ 36 km/sec. From a list of 888 stars, 78 stars were selected as objects with large space velocity components and 58 as objects with large radial velocities. These objects, altogether 120 OB stars, are listed. It is shown that the selection of runaway stars according to radial velocities is carried out with a high degree of reliability (~85%) and therefore a statistical analysis of stars with $|\Delta v_r| \geq 36$ km/sec permits to obtain reliable mean characteristics of runaway OB stars. The selection according to the components of space velocity is less certain. From a statistical analysis of the data it is shown that: (a) runaway OB stars comprise about 12% of all early-type stars, about 25% of the O stars and about 10% of the B stars are runaway objects, (b) the peculiar velocities of runaway OB stars have an isotropic distribution over all the directions and the mean space velocity is about 70 km/sec, (c) there is not a clear connection between the velocities of runaway OB stars and their spectral type, (d) the fraction of visual double stars among runaway OB stars is considerably smaller than among normal OB stars, but the fraction of spectroscopic binaries among runaway OB stars is not smaller than among normal OB stars. An attempt is made to identify the birthplaces of runaway OB stars with space groups of hot stars, bright diffuse nebulae which are excited by clusters of hot stars, and optical and radio remnants of supernova outbursts. (auth)

16714 PHYSICAL CONDITIONS IN STRONG CHROMOSPHERIC FLARES. Banin, V. G. Izv. Krym. Astrofiz. Observ., 34: 252-71(1965). (In Russian).

The determination of the mechanisms of emission broadening in chromospheric flares on the basis of the shape of line profiles is discussed, in the case when the emission is combined emission broadened by various factors. In the case of both Doppler and Stark emission, and also in the case of only Doppler emission with different $\Delta\lambda_D$, the resulting profiles can satisfy the assumption on line broadening due to motions with a non-Maxwellian velocity distribution. Combined Doppler and non-Maxwellian ($e^{-a\Delta\lambda}$) emission can lead to the broadening law $e^{-b\Delta\lambda}$ at $b \neq a$. Several physical parameters are derived for a typical strong chromospheric flare: in the hydrogen region $n_e = 3 \cdot 10^{13}$ cm^{-3} and N_2 is within the limits 10^{15} to $2 \cdot 10^{16}$ cm^{-2}, in the region of neutral helium emission T_k = 17,000°K and v_t = 5 km/sec. (auth)

16715 CONNECTION BETWEEN THE BIRTH OF STRONG FLARES AND THE APPEARANCE AND INTENSIFICATION OF SUNSPOTS. Ogir, M. B.; Shaposhnikova, E. F. Izv. Krym. Astrofiz. Observ., 34: 272-7(1965). (In Russian).

It is noted that the appearance of strong flares is often preceded by the appearance of new spots, or the intensification of spots previously existing near the location of the flare. (auth)

16716 POSITION OF MOUSTACHES IN A SPOT GROUP RELATIVE TO THE MAGNETIC FIELD. Koval, A. N. Izv. Krym. Astrofiz. Observ., 34: 278-87(1965). (In Russian).

On the basis of detailed visual measurements of magnetic fields of spot groups for 92 cases of observations of moustaches, a study was made of the location of moustaches in the spot group relative to the magnetic field. It follows that moustaches appear mainly near the line dividing the magnetic field polarities $H_{||} = 0$ and at the border of the penumbra of large spots in regions of intersersion of transversal fields. A study of the position of moustaches relative to the magnetic field by means of charts of the longitudinal and transversal fields obtained with the tower solar telescope confirms the conclusion that moustaches appear at the places of

contact crossing or divergence of fields of different directions. Hα films of spot groups in which moustaches are observed show that, in the majority of cases, moustaches appear at the places of flare brightening. The character of metallic line emission in moustaches is studied. It indicates a selective excitation mechanism acting in moustaches which leads to the emission of lines with definite excitation potentials of the upper level. The appearance of flares and moustaches in the same places with specific magnetic field configurations, the similar character of metallic line emission in flares and moustaches and also several other factors indicate their possible common nature. (auth)

16717 CHARACTER OF THE SPOT MAGNETIC FIELD IN THE CORONA. **Gopasyuk, S. I. Izv. Krym. Astrofiz. Observ., 34: 288-95(1965). (In Russian).**

On the basis of a study of the motions of absorption surges relative to the structure of the transversal magnetic field in a spot group near the central meridian (from Sept. 2 to Sept. 5, 1961) the following is concluded: as a rule the trajectories of the surges in the picture plane are not located along the transversal magnetic field structure at photospheric level; as it can be assumed that surges move along the magnetic field, this indicates a different structure of the spot magnetic field at photospheric level and in the corona. From an analysis of the differences in the structure of the magnetic field in the photosphere and the surge trajectories it is concluded that: (1) In the corona the spot magnetic field has an azimuthal component which does not depend on the rotation of the spot at photospheric level. (2) Due to the azimuthal component the spot magnetic field decreases more slowly in the corona, than in the case of a dipole field. (3) The spot fields of different polarity are closing in the corona, even in the case when there are large spots between them. (auth)

16718 PHOTOSPHERIC MAGNETIC FIELDS AND FLOCCULI BRIGHTNESS. **Tsap, T. T. Izv. Krym. Astrofiz. Observ., 34: 296-304(1965). (In Russian).**

The brightness of flocculi observed in the K_{232} Ca^+ line is compared with the longitudinal, transversal, and total photospheric magnetic fields. It is found that the flocculi brightness increases, on the average, with the strength of the longitudinal, transversal, and total magnetic fields. For all of the active region the closest relation is observed between flocculi brightness and the total magnetic field strength. At first the flocculi brightness increases with field strength and remains about constant at a given field strength. The field strength at which flocculi brightness attains a maximal value varies for different active regions and different places of one and the same active region. The transversal magnetic field strength at which the brightness of flocculi attains maximum is usually greater than that of the longitudinal field. In the penumbra the agreement is best between the brightness variations and the transversal field strength. (auth)

16719 SOME PROPERTIES OF PROTON AND NON-PROTON FLARE REGIONS. **Eliseev, G. F.; Moiseev, I. G. Izv. Krym. Astrofiz. Observ., 34: 3-8(1965). (In Russian).**

An attempt is made to find the distinguishing properties of radio emission of active regions with proton flares. It is shown that in such regions the number of flares accompanied by bursts of radio emission at centimeter wavelengths exceeds that in regions without proton flares by a factor of 3 to 4. A shift to the east of centers of condensations (at 21 cm) relative to the spot with the largest magnetic field in the group is noted for regions of both types. However the shift is smaller above regions with proton flares than above regions without proton flares. The regions do not differ practically, with regards to the intensity, of the slowly varying component of radio emission at 9 and 21 cm. (auth)

16720 DYNAMIC SPECTRA OF LARGE BURSTS OF RADIO EMISSION AT METER WAVELENGTHS. **Yurovskaya, L. I. Izv. Krym. Astrofiz. Observ., 34: 9-15(1965). (In Russian).**

Twelve bursts of radio emission in the meter wavelengths were studied. These were recorded at the Crimean Astrophysical Observatory with the λ = 1.5-meter radiotelescope and radiospectrograph with a continuous range from 2 to 3 meters. The connection between these bursts and flares in the optical region is discussed. The dynamic spectra of all of the 12 bursts are given. (auth)

16721 PROTON FLARES DURING 1961–1962 AND RELATED RADIO EMISSION. **Levitskii, L. S. Izv. Krym. Astrofiz. Observ., 34: 16-41(1965). (In Russian).**

The absorption in the polar cap determined from data on the minimal reflection frequency (f_{min}), obtained at two Soviet high-altitude stations (Heiss Island and Mirny) during 1961–1962, is compared with data on chromospheric flares. The active regions in which these flares originated are discussed and the connection between these regions and noise storms investigated. (auth)

16722 CONNECTION BETWEEN RADIO EMISSION BURSTS AT 3.2 CM AND IONOSPHERIC EFFECTS DUE TO X-RAY RADIATION OF SOLAR FLARES. **Eryushev, N. N.; Eliseeva, L. A. Izv. Krym. Astrofiz. Observ., 34: 42-52(1965). (In Russian).**

Previously it was shown that radio emission bursts in the centimeter range are strongly correlated with sudden ionospheric disturbances (SID), due to the X radiation of solar flares. The time connection is discussed between the moments of development of radio emission bursts at 3.2 cm and the ionospheric effects at atmospherics (SEA, 27 kc/sec) and in the propagation of long radio waves (SFA). It is found that in the majority of cases radio emission bursts at 3.2 cm commence earlier (by one or several minutes) than ionospheric disturbances. There are also cases when bursts at 3.2 cm and ionospheric effects appear simultaneously or the bursts lag relative to the disturbance. A comparison of the effects on atmospherics with data of direct measurements of x radiation shows that the commencements of both these phenomena coincide sufficiently well. On the basis of this, and taking into account the results of the analysis of the present investigation, it is proposed that the observed time differences between the commencements of ionospheric effects and disturbances at 3.2 cm during flares are a consequence of the physical peculiarities of generation of radio emission bursts and x radiation (the commencements of generation of x radiation responsible for a SID and bursts at 3.2 cm do not coincide in many cases). (auth)

16723 THE NATURE OF MOMENTARY INTENSITY INCREASES OF HEAVY NUCLEI DETECTED BY MEANS OF COSMIC ROCKETS AND SPUTNIKS. **Vladimirskii, B. M. Izv. Krym. Astrofiz. Observ., 34: 305-12(1965). (In Russian).**

On the basis of data of world network stations on the nucleon component of cosmic rays, it is shown that the intensity increases of heavy nuclei detected by means of the second cosmic rocket are accompanied by weak intensity increases at sea level. The source of the accelerated nuclei is on the sun, as the impact zone effect is observed. However, these phenomena are apparently not connected with chromospheric flares. (auth)

16724 ON THE CONNECTION BETWEEN THE SPORADIC IONOSPHERIC E LAYER AND SOLAR FLARES. **Vinogradov, Yu. I. Izv. Krym. Astrofiz. Observ., 34: 319-27(1965). (In Russian).**

The connection between the critical frequency variations of the sporadic ionospheric E layer (E_s), solar flares, and solar radio emission is studied on the basis of data obtained at the ionospheric station of the Crimean Astrophysical Observatory during 1958–1959. It is shown that the correlation between the variations of the monthly excesses of critical frequency of the E_s layer and solar flares is 76%. No connection between the variations of the mean critical frequency of the E_s layer and solar radio emission at 3 cm, 10 cm, and 1.5 m is observed. (auth)

16725 THE CONNECTION BETWEEN TYPE III RADIO BURSTS AND X-RAY RADIATION OF SOLAR FLARES. **Eliseeva, L. A. Izv. Krym. Astrofiz. Observ., 35: 262-4(1966). (In Russian).**

The connection between type-III radio bursts and the x radiation of solar flares is considered. The majority of the solar flares studied (80%) accompanied by x radiation do not correspond to type-III bursts. On the contrary, only 22% of type-III bursts coincide in time with ionospheric disturbances. (auth)

16726 PROTON FLARES IN 1963. **Levitskii, L. S. Izv. Krym. Astrofiz. Observ., 35: 253-61(1966). (In Russian).**

Absorption in the polar cap is compared with chromospheric flares and radio bursts. For the former, data on the minimal reflection frequencies (f_{min}) obtained at three high-altitude stations (Hayes Is, Resolute, and Cape Hallett) during 1963, were used. The active regions in which the flares originated and their connection with noise storms are discussed. (auth)

16727 DIURNAL VARIATION OF COSMIC RAYS AND ITS CONNECTION WITH SOLAR ACTIVITY. **Vladimirskii, B. M.; Pankratov, A. K.; Stepanyan, A. A. Izv. Krym. Astrofiz. Observ., 35: 222-42(1966). (In Russian).**

The mean sliding amplitudes and phases of the first harmonic of diurnal variation of cosmic rays were determined from IGY data by applying the directed intensity method. The advantages and disadvantages of this method as compared to others described in the literature are analyzed in detail. It is shown that, besides the principal afternoon zone of stable phases in diurnal variation, there is another region of relatively stable phases in the interval of 00 to 04 hours local time. Phase jumps at 180° and their connection with magnetic activity have been detected. It was found that the phase jumps occur apparently at the K_p index minimum or during magnetic storms. Two types of magnetic storms, which dif-

fer in the character of behavior of diurnal variation, were detected. One group is connected with an increase of diurnal variation before SC and the other after. The relation between magnetic storm effects on diurnal variation and the longitude of the corresponding solar flare is studied. The variation curve of diurnal variation after type-IV radio bursts, which were not accompanied by magnetic storms with SC, is obtained. Two amplitude increases are observed: on the first and third days after a burst. (auth)

16728 INFLUENCE OF SOLAR FLARES ON THE STATE OF THE LOWER IONOSPHERE. Eryushev, N. N. Izv. Krym. Astrofiz. Observ., 33: 164-72(1965). (In Russian).

SID recorded at long wave lengths (atmospherics) are discussed. Ionospheric effects of solar flares at frequencies f > 10 kc were studied previously. The behavior of long waves with frequencies of 5 and 7 kc during flares is reported here. The method used for the determination of the relative electron concentration (and therefore conductivity) in the lower ionosphere during flares is described in detail. It is found that the relative variation of electron concentration during flares decreases with increasing height. On the basis of an analysis of data on the height distribution of relative electron concentration at disturbance maximum it is concluded that the spectral intensity distribution of x radiation of solar flares varies from flare to flare. An attempt is made to estimate the energy flux of x radiation in the spectral region $\lambda < 1.5$ to 2.0 Å. It is found that at disturbance maximum, the density of the energy flux in this spectral region is within the limits 10^{-7} to 10^{-3} ergs/cm^2 sec. (auth)

16729 THE ANALYSIS OF IONOSPHERIC EFFECTS OF SOLAR FLARES REGISTERED AT LONG WAVE LENGTHS AND f_{min}. Eryshev, N. N. Izv. Krym. Astrofiz. Observ., 33: 160-3(1965). (In Russian).

It had been detected previously that SID due to x radiation of solar flares are observed two times more often at long wave lengths (atmospherics) than at f_{min}, i.e., in absorption of short wave lengths. It is shown that the observed difference in the effective appearance of disturbances is related to the distribution of additional ionization with height of the lower ionosphere, which in turn is determined by the peculiarities of ionization emission. Ionospheric disturbances are revealed in absorption of short waves or long waves, or simultaneously in both, depending on the spectral composition and spectral intensity distribution of the x radiation of solar flares. (auth)

16730 THE INFLUENCE OF SOLAR ACTIVITY ON THE PROBABILITY OF APPEARANCE OF THE SPORADIC E IONOSPHERIC LAYER. Vinogradov, Yu. I. Izv. Krym. Astrofiz. Observ., 35: 243-7(1966). (In Russian).

The relation between the probability of appearance of the sporadic E ionospheric layer and the level of solar activity is discussed on the basis of data obtained at the Ionospheric Station of the Crimean Astrophysical Observatory. It is shown that the probability of appearance of the sporadic E layer increases with the level of solar activity. The probability of its appearance in the nighttime shows a seasonal dependence and does not depend on the level of solar activity. The existence of such seasonal variation depends on the duration of daytime. (auth)

16731 X-RADIATION OF RADIO GALAXIES. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 719-23(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 897-902(Sept.-Oct. 1966).

The nature of the intense x radiation from radio galaxies is discussed. If this radiation results from the bremsstrahlung mechanism operating in large clouds of hot gas the internal energy of the gas is of the same order of magnitude as the total cosmic-ray energy in the radio galaxy. In this case the heating of the gas can result from a change of cosmic-ray energy in the course of the process of isotropization of the cosmic rays. The difficulty involved in the hypothesis of a bremsstrahlung mechanism of x radiation is that the mass of hot gas must be great for an extended source. A model of a source of bremsstrahlung nature of small dimensions also is discussed, as is the problem of the x radiation of Crab nebula. (auth)

16732 SPECTRA OF THE CHAVIRA AND ROSINO SUPERNOVAE. Dibai, E. A.; Esipov, V. F.; Pronik, V. I. (Shternberg State Astronomical Inst., USSR. Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 728-30(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 907-10(Sept.-Oct. 1966).

The spectral energy distribution is derived for Chavira's supernova in the galaxy NGC 4666 and Rosino's supernova in NGC 4753. Chavira's star belongs to type II, Rosino's to type I. (auth)

16733 THE REPLACEMENT OF RELATIVISTIC GRAVITATIONAL CONTRACTION BY EXPANSION, AND THE PHYSICAL SINGULARITIES DURING CONTRACTION. Novikov, I. D. Soviet Astron. AJ (Engl. Transl.), 10: 731-7(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 911-18(Sept.-Oct. 1966).

The relativistic gravitational contraction (collapse) of a star smaller than the gravitational radius can change to an expansion in a charged-ball model treatment, without the matter having passed through infinite density (except for the central particle). In order of magnitude $\rho \approx c^6(m^4/\epsilon^6)$ at maximum contraction, where m is the mass and ϵ is the charge. The configuration expands into "another" external space. The results suggest the general type of solution for the collapse-expansion transition of a neutral star, allowing for the instability of spherical contraction and possible processes at superhigh density ($\rho \approx 10^{93}$g/cm^3). The contraction-expansion transition for cosmological models is discussed. (auth)

16734 HYDRODYNAMICS OF ROTATING STELLAR SYSTEMS. Marochnik, L. S. (Astrophysics Inst., Academy of Sciences, Tadzhik SSR). Soviet Astron. AJ (Engl. Transl.), 10: 738-43(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 919-27(Sept.-Oct. 1966).

Anisotropic hydrodynamic equations for rotating collisionless stellar systems are derived in the drift approximation. The form of the pressure and pressure-transport tensors is indicated. A "freezing-in" principle analogous to the magnetohydrodynamic principle is formulated. Lindblad's theorem is generalized. Anisotropic equations of state are obtained for the stellar "gas." The gravitational instability of rotating systems is treated on the basis of anisotropic hydrodynamics. (auth)

16735 THE MOTION AND NATURE OF H α SPICULES IN THE SOLAR CHROMOSPHERE. Nikol'skii, G. M.; Sazanov, A. A. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 744-50(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 928-35(Sept.-Oct. 1966).

The Hα line profiles and radial velocities V_r for 11 spicules at ~6000-km height have been derived from successive Hα spicular spectra. Within 8 min, 26 spectra were recorded with 20-sec mean separation, using the Institute of Terrestrial Magnetism coronagraph (primary objective diameter 25 cm, f.l. 4m, dispersion 2 A/mm, equivalent f.l. 7m). The radial velocities vary randomly with time, with a 1-min mean period; sign changes also occur. Scattering of photospheric radiation is the chief mechanism for spicular Hα radiation. At 6000-km height spicules are optically thin in Hα ($\tau \approx 0.05$), with $T \approx 6000$°K, $n_H \approx 10^{11}$ cm^{-3}, and $n_e \approx 10^{10}$ to 10^{11} cm^{-3}. Motions of individual condensations at 10 to 20 km/sec velocity make a major contribution to the Hα line profile. About $\frac{1}{3}$ of all spicules exhibit a doublet structure; the components have nearly identical dynamic and photometric properties. The value $\frac{1}{3}$ may be a lower bound, since the observed ~3 to 4'' separation of doublet components equals the instrumental resolution. (auth)

16736 He I EXCITATION IN CHROMOSPHERIC SPICULES. Nikol'skaya, K. I. (Inst. of Terrestrial Magnetism, the Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 751-5(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 936-41(Sept.-Oct. 1966).

The possibility is considered of populating the 2^3S level of He I through ionization from the 1^1S state by radiation with $\lambda \leq 504$ A, followed by recombination on the 2^3S level. For a ≈6000°K spicule temperature the ionizing radiation flux furnished by the sun will populate the 2^3S level sufficiently to yield the observed spicular 10,830 A and D_3 He I line intensities: the computed number $N_2{}^3{}_S$ of atoms in the 2^3S state at height h ≈ 6000 km is one order greater than the value of $N_2{}^3{}_S$ derived from observations of D_3 and 10,830 A. The orthohelium lines are emitted in outer spicular layers whose temperature equals that of hydrogen emission regions. If the concentration of He I atoms in the 1^1S state in $n_1 \approx 10^{10}$ cm^{-3} (corresponding to h ≈ 6000 km above the limb), the helium "envelope" would be ~10^2 km thick. (auth)

16737 ELECTRON CONCENTRATION IN METALLIC EMISSION REGIONS IN THE CHROMOSPHERE. Shilova, N. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 756-60(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 942-7(Sept.-Oct. 1966).

The electron concentration in metallic emission regions is determined by means of the statistical equilibrium equations for one of the upper levels of Fe I, namely, $^5F_3$. The intensities of chromospheric Fe I lines observed with the IZMIRAN coronagraph are used. It is concluded that there is excess electron concentration in these regions. (auth)

16738 DIFFERENCES BETWEEN THE PROFILES OF TWO INFRARED HYDROGEN LINES IN A FACULA AND THE PHOTOSPHERE. Mitropol'skaya, O. N. (Shternberg State Astronomical Inst., USSR). Soviet Astron. AJ (Engl. Transl.), 10: 773-5 (Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 963-6(Sept.-Oct. 1966).

The profiles of the hydrogen lines λ 21,655 A (Brackett series) and λ 12,818 A (Paschen series) in a facula and the photosphere were observed with the help of a lead sulfide photocell. The profile differences were calculated for two points of the profiles ($\Delta\lambda$ = 5 A and $\Delta\lambda$ = 10 A) at the center and the edge of the solar disc. The agreement between theory and observation was satisfactory. (auth)

16739 STRUCTURE OF SUNSPOT MAGNETIC FIELDS. Zhugzhda, Yu. D. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 776-82(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 967-75(Sept.-Oct. 1966).

It is demonstrated by analysis of physical conditions in the solar atmosphere that the problem of formulating a model of the potential field of a photospheric sunspot and the field over it can be reduced to solution of the boundary-value problem for a half-space. A broad class of axially symmetrical solutions of the boundary-value problem is obtained. A principle is proposed for formulating complex magnetic field models for sunspots, using the solutions as components of these models. The possibility of formulating a potential field model for each sunspot is demonstrated. Study of the solutions revealed that within the framework of potential field theory it is possible to explain a number of sunspot magnetic field characteristics: presence of strong transverse fields, increase of the longitudinal field with height in the individual regions, impregnation of a purely transverse field in the sunspot core, rapid change of the direction of the transverse field with depth in individual regions, etc. It is felt that the proposed potential field model can be employed effectively for clarifying the problem of how well sunspot fields can be approximated by a potential field. (auth)

16740 SPECTROSCOPIC PROPERTIES OF U MONOCEROTIS. Aliev, A. A. (Shemakhin Astronomical Observatory, Azerbaidzhan SSR. Odessa Astronomical Observatory). Soviet Astron. AJ (Engl. Transl.), 10: 794-801(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 990-8(Sept.-Oct. 1966).

Curves of growth, microturbulent velocities, and the parameters T_{eff}, P_g, P_e, and ρ were determined for U Mon, and their phase variations were studied. The microturbulent velocities derived from the iron lines depend on excitation potential, presumably because the lines are formed at different levels in the stellar atmosphere. The chemical composition of the atmosphere is investigated. The mean velocity of mass outflow is 25 km/sec; the annual mass loss, $2.6 \cdot 10^{-5}$ solar masses. (auth)

16741 NITROGEN BURNING IN MASSIVE STARS. Kotok, E. V. (Astronomical Council, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 806-9(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 1004-8(Sept.-Oct. 1966).

An evolutionary model sequence is computed for a 2-solar-mass star, incorporating the nitrogen-burning reaction after complete hydrogen exhaustion in the central region. The effects of the reaction on the internal structure and external parameters of the star are described. The contributions of the various energy sources are compared. (auth)

16742 STABILITY OF RADIAL STELLAR PULSATION. Vandakurov, Yu. V. (Inst. of Technical Physics, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 810-16 (Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 1009-17(Sept.-Oct. 1966).

The stability of a nonuniform, radially pulsating, gravitating gas sphere is studied in the adiabatic approximation by the normal-oscillation method. A time-periodic perturbing force is exerted on points of the medium during the pulsation state, producing resonance excitation of other (generally nonradial) natural oscillations. The resonance condition and a formula for the time required for onset of instability are derived by perturbation theory, assuming that the periodic force is small. Several effects that might result from development of this instability are analyzed briefly. (auth)

16743 MAGNETIC FIELDS IN THE SOLAR CORONA. Ellis, G. R. A. (Univ. of Tasmania, Hobart, Australia). Nature, 213: 790-2(Feb. 25, 1967).

It has been proposed that the frequency splitting sometimes observed in type-II solar radio bursts may be caused by excitation of plasma oscillations by suprathermal electrons moving through the solar corona in the presence of density irregularities and a weak magnetic field. In these circumstances electromagnetic waves may be produced at two frequencies. The possibility was envisaged of using such observations to measure the magnetic field intensity. The present communication examines whether the bursts show the properties expected from plasma radiation theory. Available evidence does suggest that the observed pairs of bursts may well be caused by the frequency splitting of plasma radiation in the presence of a magnetic field, and the data may be used to calculate the magnetic field intensity corresponding to different values of plasma frequency. In the absence of positional measurements of the source of radiation in the solar corona it is necessary to locate the region for which the magnetic field is measured from the estimated variation of plasma frequency with radial distance. The rate of occurrence of the burst pairs appears to be sufficient to permit their use in the routine measurement of coronal magnetic fields. (auth)

16744 COSMOLOGICAL APPLICATIONS OF MOELLER'S TETRAD FORMULATION OF THE ENERGY-MOMENTUM COMPLEX. Shah, K. B. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 64: 327-32(Dec. 1966).

A satisfactory energy-momentum complex had been given by Moller in terms of suitable tetrads introduced at every point of the space-time. A brief summary of Moller's work is given. Under suitable restrictions, Moller's theory could be extended to be applicable to energy problems in relativistic cosmology. Energy of various relativistic cosmological models is computed. It is found that the total energy of the flat universe or the de Sitter universe is zero but that of the Einstein universe of radius $2R_0$ will be R_0. The energy distribution for a mass particle embedded in the homogeneous Einstein universe is also considered. The energy considerations lead to a new interpretation of the event horizon according to which the internal energy of a star, of radius equal to its Schwarzschild radius, is zero. This interpretation leads to the conclusion that the Schwarzschild radius of a star embedded in the Einstein universe increases by about 4.8% over its value when the background is considered to be empty. (auth)

16745 HELIUM DEFICIENCY IN OLD HALO B STARS. Greenstein, G. S. (Yale Univ., New Haven); Truran, J. W.; Cameron, A. G. W. Nature, 213: 871-3(Mar. 4, 1967).

Calculations show that in old halo B stars most of the helium will have diffused below the photosphere and therefore will not be detected spectroscopically. This may account for the low abundances of helium observed in these stars. (auth)

16746 ROTATION AND ELECTRON CAPTURE IN WHITE DWARFS. Occhionero, F. (Univ., Rome. CNR, Frascati, Italy). Nuovo Cimento (10), 47B: 270-80(Feb. 11, 1967).

In white dwarfs, electron capture reactions cause a dynamical instability, which is today believed to mark the end of a sequence of lasting equilibrium configurations. Some rotation can remove entirely this instability, due to the well-known stabilizing property of angular-momentum conservation. It is very likely that white dwarfs possess a sufficient amount of angular momentum, particularly if they are the burnt-out cores of somewhat massive main-sequence stars. (auth)

16747 THE INTERNAL CONSTITUTION OF SUPERSTARS. 2. CONVECTIVE STARS. Haemeen-Anttila, K. A.; Anttila, Erkki (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser A VI, No. 212, 1-14(1966).

As an application of the relativistic theory of stellar structure supermassive convective stars are studied. They are shown to be very accurately equivalent to relativistic polytropes n = 3 studied by Gratton and by Tooper. A necessary condition for the existence of a radiative core and a sufficient condition for gravitational energy release are derived. (auth)

16748 DYNAMICS OF SUPERNOVA EXPLOSION RESULTING FROM PAIR FORMATION. Barkat, Z.; Rakavy, G.; Sack, N. (Hebrew Univ., Jerusalem). Phys. Rev. Lett., 18: 379-81(Mar. 6, 1967).

Dynamical calculations of explosions triggered by pair formation are reported. This instability occurs in heavy stars prior to the formation of any elements heavier than oxygen. The implosion caused by this mechanism is easily reversed by the oxygen burning. The explosion following the implosion disrupts the star, shedding out oxygen and its direct burning products and all lighter elements which may be present in the envelope. No iron-peak elements are formed during this explosion. (W.D.M.)

16749 RADIATION FROM A CHARGED PARTICLE SPIRALING IN A COLD MAGNETOPLASMA. Mansfield, V. N. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 147: 672-80(Feb. 1967).

A charged particle spiraling in a magnetoplasma may emit Cherenkov radiation and "normal" and "anomalous" Doppler-shifted cyclotron radiation. Anomalous Doppler-shifted emission, like Cherenkov radiation, is caused by particle motion that is faster than the phase velocity of light in the medium. The exact angular and frequency spectra of the radiated power from a charged

particle spiraling in a cold magnetoplasma have been rigorously derived using a Fourier transform method. (auth)

16750 EXPANDING UNIVERSE IN CONFORMALLY FLAT COORDINATES. Tauber, G. E. (Tel-Aviv Univ., Israel). J. Math. Phys. (N. Y.), 8: 118-23(Jan. 1967).

Einstein's field equations for a homogeneous isotropic universe are written in terms of a conformally flat coordinate system for both the closed and the open cases. It is shown that these can be readily integrated for equations of state of the form $p = a\rho$ in terms of algebraic functions. Explicit solutions and expressions for the radius and Hubble factors are given for $a = 1, \frac{1}{3}$, and for $p = 0$. (auth)

16751 LUMINOSITY FLUCTUATIONS AND A LOCAL MODEL OF QUASI-STELLAR OBJECTS. Terrell, James (Los Alamos Scientific Lab., N. Mex.). Astrophys. J., 147: 827-32(Feb. 1967). (LA-DC-8214).

An attempt is made to clarify the relativistic limits on luminosity fluctuations of large sources and to give some features of a local model of quasi-stellar objects, which is more obviously consistent with these limits than are distant models. (W.D.M.)

16752 QUASI-STELLAR OBJECTS AND RADIO GALAXIES. Gold, T. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 147: 832-3(Feb. 1967).

There is one straightforward line of speculation concerning extra-galactic radio sources, according to which they are basically of one type only. Quasi-stellar objects (QSO) are then thought to be the "active" phase of radio galaxies. In the "QSO phase" relativistic gas is produced that results in radio emission continuing for long periods of time. It is suggested that a periodic optical survey of radio galaxies would be worthwhile, in hope of discovering a QSO which was only temporarily extinct and flared up again. This survey could be restricted to those with flat radio spectra, and with radio and optical sources superposed. Such a discovery would greatly increase the understanding of the QSO phenomenon by demonstrating the association with galaxies which it may be difficult to discover otherwise. (W.D.M.)

16753 TIME VARIATIONS OF THE RADIO POLARIZATION OF QUASI-STELLAR SOURCES AT 8000 MC/S. Aller, H. D.; Haddock, F. T. (Univ. of Michigan, Ann Arbor). Astrophys. J., 147: 833-7(Feb. 1967).

Time variations of the total flux density have recently been found in a number of quasars and a Seyfert Galaxy. These sources all have flat or inverted spectra in the microwave region and appear to consist of small intense radiating regions which are optically thick in this frequency range as a result of synchrotron self-absorption. Evidence is presented that three of these radio flux density variables 3C 273, 3C 279, and 3C 345 are also radio polarization variables. In the case of 3C 273 and 3C 279 the polarized flux density varies considerably more rapidly than does the total flux density. (W.D.M.)

16754 NEW SPECTROSCOPIC OBSERVATIONS OF TWENTY QUASI-STELLAR SOURCES. Lynds, C. R. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 147: 837-40(Feb. 1967).

Redshifts were determined for twenty quasars additional to those described previously (Lynds, Hill, Heere, and Stockton 1966). All spectroscopic material was obtained with the Cassegrain spectrograph of the Kitt Peak 84-inch telescope and a P829D image intensifier. The adopted redshifts, the measured wavelengths of the principal emission lines (with identifications and computed rest wavelengths), and references to the identification of the sources are given. Other spectroscopic features of the individual sources are discussed. (W.D.M.)

16755 QUASI-STELLAR OBJECT WITH A REDSHIFT OF 2.22 AND AN UNUSUAL ABSORPTION SPECTRUM. Arp, H. C.; Bolton, J. G.; Kinman, T. D. (Carnegie Institution of Washington, D. C.). Astrophys. J., 147: 840-5(Feb. 1967).

The radio source PKS 0237-23 was discovered with the Parkes telescope in a sample survey of an area of 400 square degrees at a frequency of 610 Mc. The most reliable value for the redshift comes from the measurement of the C IV line, which is reasonably strong and in the region clear of any night-sky features or absorption lines in the source itself. The spectrum of 195 Å/mm obtained with the prime-focus spectrograph at the 200-inch telescope is shown. Absorption lines are given. (W.D.M.)

16756 THE REDSHIFT AND ABSORPTION-LINE SPECTRUM OF PKS 0237-23. Burbidge, E. M. (Univ. of California, San Diego). Astrophys. J., 147: 845-8(Feb. 1967).

The striking feature of the optical radiation from PKS 0237-23, apart from its large redshift, is that it has a considerable number of absorption lines in the blue and ultraviolet, reminiscent of 3C 191, the first QSO in which a number of absorption lines were found. The wavelengths of these lines, measured on Arp's plate taken at Palomar, are given by Arp et al., together with the identifications that they have adopted. Since these identifications seem to pose some problems, the question is discussed from a different point of view. It is suggested that despite the puzzling features in 0237-23, it may be reasonable to conclude that the object has an absorption-line redshift of 1.95. (W.D.M.)

16757 RADIO AND OPTICAL DATA ON SIXTEEN QUASI-STELLAR OBJECTS. Kinman, T. D.; Bolton, J. G.; Clarke, R. W.; Sandage, Allan (Univ. of California, Santa Cruz). Astrophys. J., 147: 848-50(Feb. 1967).

The further confirmation of sixteen radio sources as quasars is reported. The radio sources are from the Parkes Catalogues for declinations 0° to +20° and 0° to −20°. Confirmation of the identifications depends in part on agreement between the measured radio and optical positions. The optical positions were measured on 20-inch Lick Astrographic plates or centered two-color 48-inch Schmidt plates. These positions, which have an estimated accuracy of ±2 arc sec, are given together with the differences in each coordinate between them and the radio positions. For each of the objects additional confirmation was obtained from an ultraviolet excess, observed either through UBV photometry or double exposure plates or from prime-focus spectra with the 120-inch or 200-inch telescope. (W.D.M.)

16758 WAVELENGTHS OF ABSORPTION LINES IN QUASI-STELLAR OBJECTS. Burbidge, Geoffrey (Univ. of California, San Diego). Astrophys. J., 147: 851-4(Feb. 1967).

There are now several quasi-stellar objects in whose spectra absorption lines have been detected. Among the seven objects so far detected with redshifts greater than 1.9, five show absorption features. These are PHL 938, 3C 191, PKS 1116 + 12, PKS 0237-23 and PHL 5200. 3C 9 and PKS 0106 + 1 show no traces of absorption features. The measured wavelengths of all the absorption features in these QSOs are shown and it is seen that the remarkable feature of these lines is that in many cases there are very close coincidences between the wavelengths measured in different objects. The consequences of this phenomenon are discussed in some detail. (W.D.M.)

16759 POSITIONAL CORRELATIONS OF GALACTIC OBJECTS AND X-RAY SOURCES. O'Dell, C. R. (Univ. of Chicago). Astrophys. J., 147: 855-7(Feb. 1967).

The discovery of an increasing number of celestial x-ray sources indicates that these sources are intrinsically rather common objects in the Galaxy. Unfortunately, accurate positions exist only for the Crab Nebula and Sco X-1 while positions accurate to about ±1° are known for several other sources. The results of a statistical analysis of the existing positional data near the galactic center are presented. Although results of a statistical study involving small numbers can be very misleading, it is shown that it is possible to make certain correlations that may prove valuable in the development of ideas about the nature of the galactic x-ray sources. (W.D.M.)

16760 THE FLUX DENSITIES OF TWENTY RADIO SOURCES AT 13.1 Mc/S. Andrew, B. H. (Cambridge Univ., Eng.). Astrophys. J., 147: 423-32(Feb. 1967).

The flux densities of twenty radio sources were measured at a frequency of 13.1 Mc/s. There is evidence of curvature at low frequencies in the spectra of ten of these sources. Several sources show enchanced emission at 13.1 Mc/s, implying an anomalously steep low-frequency spectral component. (auth)

16761 INTERPLANETARY SCINTILLATIONS. I. THEORY. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 147: 433-48(Feb. 1967).

The scintillations of small-diameter radio sources over time periods of the order of 1 sec are thought to be caused by electron-density fluctuations in the interplanetary medium, carried along by the solar wind. Some aspects of the theory had been presented by previous authors, all in the "thin phase screen" approximation, but not for all possible regimes. This theory is now extended to the regime where the rms phase fluctuations are large and distances to the screen are comparable with typical "focal lengths." Both the spatial autocorrelation function for intensity and also the distribution of intensities are discussed for all regimes. A simple formula is derived for the effect of a finite angular source size on the frequency spectrum of the scintillation autocorrelation function for any regime. Sufficient conditions for the validity of the "thin phase screen" approximation are derived. The cross-correlation between scintillations at different radio frequencies is discussed. A lower limit is derived for the distance from the irregularities to Earth. (auth)

16762 INTERPLANETARY SCINTILLATIONS. II. OBSERVATIONS. Cohen, M. H.; Gundermann, E. J.; Hardebeck, H. E.; Sharp, L. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 147: 449-66(Feb. 1967).

Observations of interplanetary scintillations have yielded the statistical quantities needed to fix the scattering regime. The observations fit the theory rather well and show that the fluctuations in electron density have a correlation length of 110 km. The rms density variation is given approximately by $\Delta n = 0.14r^{-2}$ cm^{-3} (r = radial distance from the sun in astronomical units) for $0.2 < r < 0.9$, in the equatorial region of the corona, during September–November, 1965. The effect of angular extension of the source on the fluctuation spectrum of scintillations is discussed, and it is shown that the sources 3C 138 and 3C 273 have components with angular size ~0.1″ and ≤0.02″, respectively. (auth)

16763 LEAST-SQUARES FIT OF A GAUSSIAN TO RADIO SOURCES. von Hoerner, S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 147: 467-70 (Feb. 1967).

A general program is described for the least-squares fit of a Gaussian to an observed scan or to a restored lunar-occultation record. The program is written as a FORTRAN subroutine. It consists of 650 cards and occupies about 4000 memory words. The program solves for four parameters: position ϑ, width β, area F, and height of zero line r. It performs five tasks: (1) It finds a "first guess" for ϑ and β from the input data. (2) It iterates (by varying ϑ and β, and solving directly for F and r) until final values for the four parameters are obtained. (3) It gives the mean errors for these values. (4) It calculates the diameter of the source and its mean error. (5) It makes two independent reliability tests, yielding the level of significance for any systematic deviations of the data from a Gaussian. The program handles both correlated and uncorrelated noise; many checks and safety features are included. The methods chosen for the mean errors and for the reliability tests are not specific for a Gaussian; they can be used for most other cases of curve fitting as well. (auth)

16764 GALACTIC H II REGIONS. I. OBSERVATIONS OF THEIR CONTINUUM RADIATION AT THE FREQUENCY 5 GHz. Mezger, P. G.; Henderson, A. P. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 147: 471-89 (Feb. 1967).

The continuum radiation of thirteen galactic radio sources was mapped at a wavelength $\lambda = 6$ cm. The NRAO 140-foot telescope was used for this survey; the half-power beam widths are 6.45′ (E plane) and 6.3′ (H plane), the beam efficiency is 0.81 and the aperture efficiency is 0.525 at this wavelength. Most of the investigated sources are resolved into two or more components. The peak temperatures and the half-power widths of these components are computed by fitting Gaussian curves through the measured cross sections. The flux densities of the bright emission centers and the integrated flux density of the total radio source (after separation from the unresolved background radiation) are given. The positions of the emission centers are given with an accuracy between ±1′ and ±3′. The observation of the hydrogen 109α recombination line of these sources allows an unambiguous identification of H II regions as well as an estimate of their distances and electron temperatures. The measured flux densities, together with these latter parameters, yield the total mass of ionized hydrogen, the average electron densities, and the maximum emission measures for the bright emission centers of the investigated H II regions. (auth)

16765 GALACTIC H II REGIONS. II. OBSERVATIONS OF THEIR HYDROGEN 109α RECOMBINATION-LINE RADIATION AT THE FREQUENCY 5009 MHz. Mezger, P. G.; Hoeglund, B. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 147: 490-518(Feb. 1967).

The hydrogen 109α recombination line spectrum of twenty galactic radio sources was investigated, using a 20-channel frequency switched line radiometer (channel width 95 k Hz) together with the NRAO 140-foot telescope. Sixteen of the investigated sources show line emission. The observations yield the ratio of excess line to free-free continuum temperature $(T_{L+C} - T_C)/T_C$ and the radial velocity of the H II region. The line width $\Delta\nu_L$ was determined by fitting a Gaussian profile to the observed points. The kinematic distances of the H II regions are estimated from the observed radial velocities. The distribution of the H II regions, projected on the galactic plane, is compared with a similar analysis from optically derived distances of H II regions in the vicinity of the Sun made by Becker and Fenkart. The rms velocity of the peculiar motion of the H II regions is found to be less than 7 km/sec. The electron temperatures of the H II regions are determined from the observed quantity $\Delta\nu_L(T_{C+L} - T_C)/T_C$, assuming thermal equilibrium. A mean value of 5800°K is found with individual values ranging from 4000° to 9500°K. The observational results are compared with Goldberg's prediction of enhanced line radiation due to stimulated emission. Since Doppler broadening is the only effective broadening mechanism for the observed 109α lines, the rms velocity of the internal turbulence in the H II regions was determined from the observed line widths. The mean value of fifteen H II regions yields 19.25 km/sec, a value which is more than twice the velocity of sound at T_C = 5800°K. The non-detection of the 109α line is used to identify non-thermal sources in the Sgr A region and in the radio source associations W49 and W51. The velocity dispersion of H II regions and nearby OH clouds which show the 18-cm line in emission is found to be 7.9 km/sec. (auth)

16766 ON THE EVOLUTION OF GALACTIC NUCLEI. II. Spitzer, Lyman Jr.; Stone, Michael E. (Princeton Univ. Observatory, N. J.). Astrophys. J., 147: 519-28(Feb. 1967).

The evolution of a very compact stellar system, under the influence first of evaporation of stars and next of direct collisions between stars, is followed to a later stage than that analyzed by Spitzer and Saslaw, to investigate how the luminosity varies with time. On the assumption that the angular momentum per unit mass is constant, the contraction is limited by the initial angular momentum. If ϵ, the ratio of the system's rotational velocity to the random stellar velocity, is between 0.1 and 0.01 when collisions begin to dominate over evaporation (state 1), the total energy release is between 5×10^{58} and 5×10^{60} ergs. The detailed rate of energy liberation depends on the exchange of random kinetic energy between the old stars, which collide and liberate gas, and the new stars that form from the gas after this has fallen to the galactic center. This exchange, which takes place through distant gravitational encounters, leads to a contraction of the system of old stars, increases the collision rate, accelerates the contraction and enhances the luminosity. If this exchange is ignored in the later stages of evolution, then in a system of mass 10^8 M⊙ the peak luminosity is 2×10^{42} or 2×10^{44} ergs/sec, for ϵ equal to 0.1 or 0.01, respectively, and is prolonged over a period of more than 10^8 years. In a model which considers the maximum possible rate of energy exchange the peak luminosity is increased by more than an order of magnitude, but its duration becomes less than 10^7 years. The optical thickness of the infalling gas for electron scattering rises to a value of between 5 and 50, for ϵ equal to 0.01, and for the highest luminosities most of the photons emitted will tend to originate in the freely falling gas rather than from the disk of gas and stars at the galactic center. (auth)

16767 THE ELECTROMAGNETIC SPECTRUM OF ETA CARINAE. McCray, Richard (Univ. of California, Los Angeles). Astrophys. J., 147: 544-55(Feb. 1967).

A physical model for the object η Carinae is described under the assumption that the optical continuum is synchrotron radiation. The absence of measurable radio emission is interpreted as the Razin effect. Strong radio emission at higher frequencies is predicted. The X-ray and γ-ray fluxes from the object due to inverse Compton scatterings are estimated. It is shown that the flux of ~100 MeV γ-rays should be measurable, while the X-ray flux is more uncertain. The interrelationship of fluxes in the centimeter-millimeter radio band, infrared, X-rays, and γ-rays is discussed. (auth)

16768 IONIZATION AND THERMAL EQUILIBRIUM OF A GAS EXCITED BY ULTRAVIOLET SYNCHROTRON RADIATION. Williams, Robert E. (Univ. of Wisconsin, Madison). Astrophys. J., 147: 556-74(Feb. 1967).

The ionization and thermal balances are considered for a gas that is ionized by a dilute radiation field, taking into account the diffuse ionizing radiation produced by the gas. A number of models are constructed in which the electron temperature and the ionization of the elements H, He, C, N, O, Ne, and Mg are determined for optically thin and optically thick gases ionized by ultraviolet synchrotron radiation under different conditions. Conclusions are then drawn about the general characteristics of ionization by synchrotron radiation. It is shown that in an optically thin gas, because of the insensitive frequency dependence of synchrotron radiation, each element occupies a number of different stages of ionization at any one point in the gas. It is also shown that in an optically thick gas the heavy elements remain ionized to much greater distances from the source than hydrogen and helium, and that the gas becomes thermally unstable when hydrogen and helium have become almost completely neutral. In addition, observations of the emission-line intensities of the Crab Nebula are compared with a model of this object. Considerable disagreement exists between the observed and predicted intensities, and possible reasons for the discrepancy are discussed. (auth)

16769 INFRARED SPECTRA OF LOW-TEMPERATURE STARS. McCammon, D.; Muench, G.; Neugebauer, G. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J., 147: 575-86(Feb. 1967).

Spectra of stars of types M, N(R), and S, as well as of NML objects in Cygnus and Taurus, are presented in the regions λλ1.5–1.8 μ and λλ1.9–2.5 μ. In M stars the absorption due to stellar H_2O is apparent from the wings of the bands at λ1.4, λ1.9, and λ2.7 μ. Stars of N and S types show weaker H_2O absorption. The $\Delta\nu = 2$ and $\Delta\nu = 3$ vibration-rotation band sequences of CO appear well marked in all stars, being somewhat weaker in the M types than in other stars. The late N stars Y CVn and U Hyd show a sharp discontinuity or band head at λ1.76 μ not present in other stars. The entire spectra of Y CVn and U Hyd shortward of this discontinuity appears veiled, the $\Delta\nu = 3$ CO band sequence being conspicuously weak. The spectra of the NML objects in Cygnus and Taurus have spectral characteristics resembling the carbon more than the M stars. (auth)

16770 THE ABUNDANCE OF LITHIUM IN EARLY M-TYPE STARS. Merchant, Ann E. (Univ. of California, Mt. Hamilton). Astrophys. J., 147: 587-608(Feb. 1967).

A spectroscopic survey was made of early M-type stars at 38 and 88 Å/mm with the grating spectrograph of the Lick 36-inch refractor, to search for stars possessing a strong Li I line at λ6707. For 58 early M-type giants and supergiants high-dispersion spectra (4, 8, and 16 Å/mm) were obtained with the coudé spectrograph of the 120-inch reflector. The abundance of Li relative to Ca was determined using a fairly standard curve-of-growth technique. This abundance ratio, Li/Ca, ranges in M stars from about 2 to 10^{-2} times the Greenstein–Richardson solar value. On the basis of these results and Iben's theory of post-main-sequence dilution of Li, it is not necessary to postulate that Li is formed on the surfaces of evolved stars. Li abundances are now available for giant stars over the spectral type interval F3-M4; there is a steady decrease of Li abundance with advancing spectral type for these giants, which is thought to be due to increasing convective dilution as a star evolves to the right in the H-R diagram. The concentrations of the molecules LiH, LiO, and LiOH were evaluated and found to be negligible relative to atomic Li. A comparison of the resonance lines of Li I and Na I showed no correlation, but the equivalent widths of the D-lines were found to range over a factor of 2 for a given spectral type and luminosity class. A tendency was found for the Li-rich stars to be high-velocity objects. Only four stars show more Li than the sun; there is no difficulty understanding an excess over the solar value on the basis of an initial T Tauri-like abundance and post-main-sequence convective dilution of Li. (auth)

16771 QUASI-HOMOLOGY RELATIONS AND THE EGGEN–SANDAGE RESIDUE. Faulkner, John (California Inst. of Tech., Pasadena). Astrophys. J., 147: 617-23(Feb. 1967).

Quasi-homology relations for stellar models in the theoretical Hertzsprung–Russell and mass-luminosity diagrams are described. Application to the extreme field subdwarf data of Eggen and Sandage suggests that such stars contained at least 20 per cent by mass of helium at the time of their formation. The consequences of assuming that globular cluster stars contain a typical Population I helium content are briefly discussed. (auth)

16772 STELLAR EVOLUTION. VI. EVOLUTION FROM THE MAIN SEQUENCE TO THE RED-GIANT BRANCH FOR STARS OF 1, 1.25, AND 1.5 SOLAR MASSES. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 147: 624-49(Feb. 1967).

Evolution from the main sequence to the red-giant phase is discussed for Population I stars of mass $M/M_\odot = 1$, 1.25, and 1.5. Prior to the giant phase in all three stars, energy generation by the p-p chain reactions dominates over energy generation by the CN cycle reactions. During the main hydrogen-burning phase, a convective core is not present in the 1 M⊙ star but does occur in both the 1.25 M⊙ and 1.5 M⊙ stars. Over a major portion of the main-sequence phase, the convective core grows in both the 1.25 M⊙ and 1.5 M⊙ stars as the CN cycle reactions become increasingly important. As each star rises along the red-giant branch, the CN cycle reactions eventually become the major source of energy in the hydrogen-burning shell. The time spent by a star burning hydrogen in a thick shell relative to the time spent in the core hydrogen-burning phase is found to be a strongly decreasing function of stellar mass. Partially responsible for this mass dependence are three factors: (1) for more massive stars, the mass fraction in the convective core, and hence the mass over which hydrogen is exhausted at the end of the core hydrogen-burning phase, is closer to the effective Schönberg–Chandrasekhar limit; (2) with decreasing stellar mass, the variation of hydrogen through the shell becomes more gradual, and (3) with decreasing mass, electron degeneracy becomes more important in the hydrogen-exhausted core during the thick shell-burning phase. The latter two factors have the effect of increasing the Schönberg–Chandrasekhar limit. Electron degeneracy is responsible for a major fraction of the pressure and electron conduction is the major mode of energy flow in the hydrogen-exhausted core of all three stars during the giant phase. The result is that all three stars possess a nearly isothermal core along the giant branch. During and following the shell-narrowing phase in all three stars, the surface lithium abundance decreases regularly with decreasing surface temperature as envelope convection extends deeper and deeper into the star. Such is the case also for the surface ratio of ^{12}C to ^{14}N. Comparatively large amounts of ^3He are made in all three stars, and it is suggested that a large fraction of the ^3He in the galactic disk was perhaps formed in ordinary stars. Comparison of individual tracks with cluster diagrams for NGC 188 and M67 provides evidence for the qualitative correctness of several characteristic features of the theoretical tracks. The pronounced and rapid change in luminosity and in surface temperature during the phase of over-all contraction is related to a "gap" in M67; the decrease with decreasing mass in the magnitude of the luminosity drop during the shell-narrowing phase is related to the change with cluster age in the slope of the subgiant branch; for a given luminosity, the decrease with decreasing mass in surface temperature along the giant branch is related to the decrease with increasing cluster age in surface temperature along the cluster giant branch. The ages of NGC 188 and M67 are estimated to be $(11 \pm 2) \times 10^9$ yr and $(5.5 \pm 1) \times 10^9$ yr, respectively. (auth)

16773 STELLAR EVOLUTION. VII. THE EVOLUTION OF A 2.25 SOLAR MASSES STAR FROM THE MAIN SEQUENCE TO THE HELIUM-BURNING PHASE. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 147: 650-63(Feb. 1967).

Prior to reaching the giant phase, the evolution of a 2.25 M⊙ star is qualitatively identical with the evolution of more massive stars. After reaching the giant branch, 2.25 M⊙ evolution is quite similar to that of lighter stars. The 2.25 M⊙ star is very near the limiting mass above which helium flashing will not occur. Near the top of the red-giant branch, nuclear burning via the $^{14}N \rightarrow {}^{18}O$ reactions is initiated in an electron-degenerate core. The ensuring development of the "^{14}N-flash" phase is followed until the star begins to descend from the red-giant tip. (auth)

16774 GRAVITATIONAL RADIATION FROM NEUTRON STARS. Chau, Wai-yin (Columbia Univ., New York). Astrophys. J., 147: 664-71(Feb. 1967).

Gravitational radiation from pulsating and rotating objects is calculated using the formula obtained with the weak field limit of general relativity. The cases of rotation and oscillation are first considered separately. Then the effects of rotation on radial oscillations are investigated. Numerical estimates are made with data relevant to a neutron star. It is concluded that most of the energy a neutron star may acquire during its formation is dissipated rapidly, unless the rotation is quite slow. (auth)

16775 A NEW DETERMINATION OF THE $^{12}C/^{13}C$ ISOTOPIC ABUNDANCE RATIO IN THE SOLAR PHOTOSPHERE. Herzberg, Luise (Defence Research Telcommunications Establishment, Ottawa); Delbouille, L.; Roland, G. Astrophys. J., 147: 697-702 (Feb. 1967).

The λλ3874-3875 Å region of the solar spectrum is re-examined for the occurrence of lines of the 0-0 band of the ultraviolet system of the ^{13}CN isotopic molecule. Although the well-known solar line λ3874.341 Å is in excellent wavelength agreement with the P(58) line measured in the laboratory, the P(57) line that should also occur in a window in the solar spectrum is found to be absent. It is, therefore, concluded that the wavelength agreement in the case of the P(58) line is spurious and that no lines of ^{13}CN are observed. From this, a lower limit $R \simeq 40$ for the $^{12}C/^{13}C$ abundance ratio in the photosphere is obtained. (auth)

16776 THE SPECTRUM OF THE QUIET SUN BETWEEN 30 AND 128 A FOR NOVEMBER 1965. Manson, James E. (Air Force Cambridge Research Labs., Bedford, Mass.). Astrophys. J., 147: 703-10(Feb. 1967).

The AFCRL grazing-incidence grating monochromator previously used with photoelectric detection was modified for use with a thin-window flow Geiger detector and a 2400 l/mm gold replica grating. This combination allowed coverage of the wavelength region from 30 to 128 Å with a resolution of 0.2 Å in an experiment launched at local noon on November 3, 1965, at the White Sands Missile Range, using an Aerobee rocket to carry the instrument to 213-km altitude. The instrument was pointed at the sun during the data-acquistion period, and was restored

and recovered with only minor damage. Preliminary analysis of the data indicates the presence of over 100 lines, each less than 0.003 erg cm^{-2} sec^{-1} in intensity. The total intensity for the entire 30-128 Å interval was between 0.1 and 0.2 erg cm^{-2} sec^{-1} at Earth distance. (auth)

16777 SPIKE BURSTS DURING THE TYPE-IV EVENT OF FEBRUARY 5, 1965. Malville, J. McKim; Aller, H. D.; Jensen, C. J. (Univ. of Michigan, Ann Arbor). Astrophys. J., 147: 711-17(Feb. 1967).

The rise and decay times of over 400 spike bursts observed at 345 and 230 Mc/s are discussed; the mean decay times at the two frequencies are 0.06 and 0.09 sec, respectively. The restrictions placed upon proposed mechanisms for storm bursts by the short-duration spike bursts are discussed. It is concluded that velocities of particle streams which may be responsible for the bursts lie between approximately 1.6 and 6×10^9 cm/sec. (auth)

16778 OBSERVATIONS OF AN INFRARED STAR IN THE ORION NEBULA. Becklin, E. E.; Neugebauer, G. (California Inst. of Tech., Pasadena). Astrophys. J., 147: 799-802(Feb. 1967).

In Jan. 1965, an intensity map of the Orion Nebula in the wavelength region from 2.0 to 2.4 μ was made using a dual-beam photometer mounted at the Cassegrain focus of the 60-inch telescope at Mount Wilson. Seven point sources were detected which could be identified positively with photographically visible stars, and one source was found which could not be identified. During the winter of 1966 photometeric observations at $\lambda\lambda 1.5-1.8$ μ, 2.0-2.4 μ, 3.1-3.8 μ, and 8.5-13.5 μ were made of this infrared source using the 24-inch reflector at Mount Wilson and the 200-inch telescope at Mount Palomar. The nature and position of this infrared object are discussed. (W.D.M.)

16779 ABSORPTION LINES IN NEUTRON-STAR SPECTRA. Onyejuba, P. E.; Gaustad, J. E. (Univ. of Nigeria, Nsukka). Astrophys. J., 147: 806-8(Feb. 1967).

Morton (1964) computed the gray model atmospheres for neutron stars, and Orszag (1965) computed the continuous spectra in several cases, taking into account possible absorption edges. Orszag's calculations predict the existence of sharp discontinuities in the spectra of the cooler models, which would distinguish neutron stars from other possible x-ray sources. However, in the spectra of many classes of stars strong absorption lines also modify the continuous spectrum considerably. The importance of absorption lines in the spectra of neutron stars is estimated. (W.D.M.)

16780 PROBLEMS RELATING TO MAGNETIC FIELDS IN NEUTRON STARS. Manley, Oscar P. (American Science and Engineering, Inc., Cambridge, Mass.). Astrophys. J., 147: 808-9(Feb. 1967).

Within the last few years a number of papers on x-ray emission from neutron star magnetospheres have been published. All these papers hinge on the suggestion (Woltjer 1964) that the magnetic field in a neutron star may be as large as 10^{14} to 10^{16} gauss. Certain consequences of Woltjer's suggestion are pointed out which militate strongly against the viability of the proposed magnetic neutron star configurations. (W.D.M.)

16781 INVESTIGATION OF A NEW STATE IN ^{15}O NEAR THE $^{14}N + p$ THRESHOLD. Hensley, David C. (California Inst. of Tech., Pasadena). Astrophys. J., 147: 818-19(Feb. 1967).

The recent discovery of a state in the nucleus of ^{15}O at a reported excitation of 7284 ± 7 keV, only 8.8 ± 7 keV below the $^{14}N + p$ threshold at 7292.8 ± 1.2 keV has raised some question concerning the validity of the calculations by Caughlan and Fowler (1962) of the rate of the nuclear reaction, $^{14}N(p,\gamma)^{15}O$ in stars. In order to determine the contribution of this state to the stellar reaction rate, the excitation of this state was remeasured and the spin was determined. From the measurements it is concluded that no change need be made in the calculated stellar rate for the $^{14}N(p,\gamma)^{15}O$ reaction. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 16575, 16921, 16985, and 17238.

16782 (AD-639196) ABSOLUTE MEASUREMENTS OF TOTAL CROSS SECTIONS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS BY ATOMIC AND MOLECULAR OXYGEN. Sunshine, Gabriel; Aubrey, Bertrand B.; Bederson, Benjamin (New York Univ., N. Y. Dept. of Physics). Sept. 1, 1966. Contract Nonr-285(60). 39p. CFSTI $3.00 cy, $0.65 mn.

The atom beam recoil technique was used to measure absolute total cross sections for the scattering of electrons by atomic and molecular oxygen at 22 energies between 0.5 and 11.3 eV, with additional data obtained up to 100 eV. In this method, a modulated electron beam cross-fires an atom beam, whose attenuation at the modulation frequency is observed. The angular resolution in the electron polar scattering angle ranges from about 15.6 degrees at 1 eV to 9.6 degrees at 12 eV, for 0, and from about 18.5 degrees at 1 eV to 11.4 degrees at 12 eV, for 02. The absolute values for 02 between 0.5 and 11.3 eV are between 10 and 20% higher than those of Bruche, while the shape of the curve agrees well. The atomic cross sections vary from about 5.3 sq. A at 0.5 eV to 8.3 sq. A at 11.3 eV, with an estimated error of 20% except for the 0.5 eV point which has an error of 30%. These results are in excellent agreement with semi-empirical calculations of Cooper and Martin and Robinson and Geltman, as well as with the polarized orbitals calculation of Temkin. (auth)

16783 (AERE-L-170) ATOMIC AND MOLECULAR COLLISIONS. Burke, P. G. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1967. 271p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 36s.

A lecture course given at Princeton University, USA, during April and May 1966, is reproduced (25 lectures). The emphasis throughout the course was on recent theoretical developments. (auth)

16784 (RM-1416-AEC) ATOMIC ENERGY LEVELS FOR THE THOMAS-FERMI AND THOMAS-FERMI-DIRAC POTENTIAL. Latter, Richard (RAND Corp., Santa Monica, Calif.). Oct. 19, 1954. Contract AT(04-3)-414; Subcontract SC-64. 35p. DTIE.

The eigenvalues of the Schrödinger equation were obtained for the Thomas-Fermi and Thomas-Fermi-Dirac atomic potentials. Electron self-interactions were taken into account by modifying the potentials to give asymptotically the field of a unit charge. All levels were treated from 1s to 7d for a range of Z values sufficient to permit easy interpolation. It was found that the energies, for either the Thomas-Fermi or Thomas-Fermi-Dirac potentials, agree in general as well with experimental ionization energies as the Hartree or Hartree-Fock approximations. Applications of the statistical potential to other atomic problems are indicated. (auth)

16785 (UCRL-17286) PART I, INTENSITY CORRELATIONS IN INELASTIC SCATTERING EXPERIMENTS. PART II, THEORY OF QUANTUM BEAT AND LEVEL CROSSING EXPERIMENTS UTILIZING ELECTRONIC EXCITATION. Kelly, Robert L. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 10, 1966. Contract W-7405-eng-48. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Part I. Measurements of space-time correlations in the intensity of a beam of scattered particles yield information about the scatterer. Goldberger and Watson have developed a theory of such measurements appropriate to the case of nearly elastic scattering; here their theory is extended to the case of inelastic scattering. The main result is that under certain experimental conditions the correlated counting rate in an inelastic scattering experiment is of a form equivalent to the correlated counting rate for an incoherent beam of particles emitted by a source. This result applies, in particular, to Raman or Brillouin scattering of light by phonons in an extended target. However, estimates of the signal-to-noise ratio for this case indicate that it may not be possible to observe intensity correlations in Raman or Brillouin lines using presently available light sources. Part II. The coherent excitation of several atomic states by inelastic electron scattering and their subsequent radiative decay is considered. General expressions for the photon counting rate in a quantum beat experiment, and the total number of photons counted in a level-crossing experiment are derived. The general results are used to calculate the phase of the oscillatory part of the photon counting rate in the Hadeishi-Nierenberg quantum beat experiment. (auth)

16786 FOCUSING OF CHARGED PARTICLES WITH HEMISPHERICAL GRIDS. Reynolds, R.; Scherb, F. (Univ. of Wisconsin, Madison). Rev. Sci. Instrum., 38: 348-52(Mar. 1967).

A theoretical analysis was carried out to determine the trajectories of charged particles incident upon a pair of concentric spherical grids, where the inner grid is maintained at a large accelerating potential with respect to the outer grid. The results show that under certain conditions a beam of charged particles incident on the outer grid is sharply focused inside the inner grid. These results were confirmed experimentally using hemispherical grids and electron beams. (auth)

16787 LEAKY SPACE-CHARGE WAVES. II, SMITH-PURCELL RADIATION. Palocz, I. (New York Univ., Bronx); Oliner, A. A. Contracts Nonr 285(66); AF19(628)-4324. Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 46-56(Jan. 1967).

A theoretical approach for analyzing Smith-Purcell radiation is presented. The theory is self-consistent, i.e., it takes into account the effect of the radiation back on the beam. This approach is not

only more precise than a previous one, but it brings to light a number of new effects. It shows that two kinds of waves contribute to radiation, namely, slow and fast space-charge waves, and demonstrates that these waves are of leaky nature. The numerical results show in detail that there is an optimum beam thickness and an optimum beam velocity. (auth)

16788 IONIZATION OF NEUTRAL ATOMS BY ELECTRON IMPACT. Gulyaev, R. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Academy of Sciences, USSR). Soviet Astron. AJ (Engl. Transl.), 10: 761-5(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 948-53(Sept.-Oct. 1966).

Experimental data on the cross sections for the ionization of neutral atoms by electron impact are reviewed. Formulas for the ionization probabilities when the electron velocity distribution is Maxwellian are obtained on the basis of the experimental data. (auth)

16789 ABSOLUTE CROSS SECTIONS FOR EXCITATION OF HELIUM LEVELS BY LOW-ENERGY ELECTRONS. Zapesochnyi, I. P. (Uzhgorod State Univ., Ukrainian SSR). Soviet Astron. AJ (Engl. Transl.), 10: 766-72(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 954-62(Sept.-Oct. 1966).

New data on the absolute excitation cross sections of the helium atom in collisions with slow electrons were obtained. It was found that the excitation of the majority of the helium levels is characterized by two maxima, one of which is situated directly at the threshold. Certain regularities in the behavior of the cross sections of the level are noted and these serve as a basis for the prediction of the absolute excitation cross sections of the resonance and both metastable levels in the region of electron energies from threshold to 120 to 160 eV. On the whole, there is satisfactory agreement with theory of the absolute excitation functions of the $2\,^1S$, $2\,^3S$, and $2\,^3P$ levels. A complete list of cross sections for the excitation of helium levels whose values exceed 10^{-20} cm^2 at excitation maximum is given. (auth)

16790 ELASTIC AND INELASTIC SCATTERING OF ELECTRONS BY ATOMIC HYDROGEN IN OCHKUR APPROXIMATION. Jha, R.; Banerjee, S. N.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Ind. J. Phys., 40: 491(Aug. 1966).

Ochkur's approximation was used to determine the 1S-1S elastic scattering of the electron by hydrogen at 13.6 eV and to find the degree of 1S to 2S state excitation of the hydrogen atom when the energy of the incoming electron is 11.7 eV. The total elastic cross section (1S-1S) for 13.6 eV turned out to be 8.88 πa_0^2(a_0 – Bohr radius) compared with the value 4.748 πa_0^2 obtained by Burke et al. from close-coupling approximation. The total excitation cross section (1S-2S) was 0.292 πa_0^2 compared to Burke's value of 0.26 πa_0^2. (W.D.M.)

16791 ELASTIC SCATTERING OF ELECTRONS BY HELIUM ATOM IN OCHKUR APPROXIMATION. Banerjee, S. N.; Jha, R.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 40: 489-90(Aug. 1966).

The Ochkur approximation was applied to the elastic scattering of electrons at 100 eV by the helium atom where Born's approximation is expected not to be valid, particularly for differential cross sections, $I(\theta)$, at very small angles of scattering. $I(\theta)$ at 100 eV were computed for angles from 0 to 180°. It was found that the marked disagreement between the experimental findings of Hughes et al. (1932) and the results of theoretical calculations of Khare and Moiseiwitsch (1965) using static field approximations is considerably removed, particularly at forward scattering angles. (W.D.M.)

16792 SOLUTION OF THE NONRELATIVISTIC QUANTUM SCATTERING PROBLEM WITHOUT EXCHANGE. Johnson, B. Robert; Secrest, Don (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 7: 2187-95(Dec. 1966).

The method of "amplitude density functions" is a new formalism which allows a scattering problem to be broken up into problems with weaker interaction potentials. These simpler problems may be solved separately and be "added" together to give the total solution. A numerical method is discussed which takes advantage of this property. The formulas are given for the use of this method in the solution of the one-dimensional atom–molecule collision and the e^+–H collision. A numerical example is discussed. (auth)

16793 RELATIONSHIP BETWEEN LINEAR RESPONSE THEORY AND THE BOLTZMANN EQUATION FOR A WEAKLY INTERACTING SYSTEM OF ELECTRONS AND PHONONS. Chester, G. V.; Sykes, J. (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 7: 2251-60(Dec. 1966).

Van Hove's weak coupling master equation and the factorization theorem of Kac are used to show that the transport coefficients derived from linear response theory are equivalent to those derived from the Boltzmann equation for a weakly interacting system of electrons and phonons. (auth)

16794 A STUDY OF THE CHARGE NEUTRALIZATION OF FAST Ne^+, Ar^+, AND Kr^+ IONS DURING PASSAGE THROUGH GASEOUS TARGETS. Wittkower, A. B.; Gilbody, H. B. (London Univ.). Proc. Phys. Soc. (London), 90: 353-60(Feb. 1967).

Studies of the charge neutralization of 60- to 450-keV Ne^+, Ar^+ and Kr^+ ions during passage through both "thin" and "thick" targets of hydrogen and the rare gases have allowed the total charge transfer cross section Q and the equilibrium neutral fraction F_{0_∞} to be determined. In three cases, curves showing the variation of Q with impact energy show unexpected secondary maxima which are probably due to a process of charge transfer with simultaneous multiple ionization of the target. (auth)

16795 DISSOCIATION OF HIGH-ENERGY IONIZED HYDROGEN MOLECULES IN HELIUM GAS. Farina, J. E. G. (London Univ.). Proc. Phys. Soc. (London), 90: 323-32(Feb. 1967).

The Born and closure approximations are used to obtain an expression (in the form of a series) for the dissociation cross section σ_1 for the process $H_2^+ + He \rightarrow H + H^+ + He$. Taking the first term only of the series, and assuming the LCAO approximation for the H_2^+ wave function, that overlap terms can be neglected, and that the hydrogen and helium atoms are in their ground state after the collision, the high-energy limit for the dissociation cross section is found to be $1.59 \times 10^{-14}/E$ cm^2, where E is the energy of the incident H_2^+ in keV, as compared with the experimental values $1.25 \times 10^{-14}/E$ cm^2, or $1.10 \times 10^{-14}/E$ cm^2. The effect of initial vibrational excitation of the H_2^+ is also examined, and found to increase σ_1 by up to 20%, comparable with the experimental results of Barnett and Ray, and McClure for the discussion of H_2^+ in hydrogen gas. (auth)

16796 USE OF DIAMOND FOR PHOTOSTIMULATED ULTRAVIOLET RADIATION DOSIMETRY. Miyashita, K.; Henisch, H. K.; Toole, J. (Pennsylvania State Univ., University Park). Solid-State Electron., 10: 193-7(Mar. 1967).

Natural diamond with a suitable trap distribution, induced by neutron bombardment, is shown to have uv dosimetric capabilities, based on the measurement of infrared photostimulated current pulses. (auth)

16797 MINIMUM ENERGY OF POSITRONS IN METALS. Kim, S. M. (Univ. of North Carolina, Chapel Hill); Stewart, A. T.; Carbotte, J. P. Phys. Rev. Lett., 18: 385-7(Mar. 13, 1967).

It is reported that positrons are not always thermalized before annihilation in metals and thus the ultimate resolution of the technique is limited. The experimental and theoretical properties of this phenomenon are outlined, and results are presented for positron annihilation in lithium, sodium, potassium, and rubidium at various temperatures. It is found that there is a clearly defined ultimate minimum energy of positron annihilation in metals. (J.F.P.)

16798 CAVITY FORMATION IN HELIUM. Roellig, L. O.; Kelly, T. M. (Wayne State Univ., Detroit). Phys. Rev. Lett., 18: 387-90(Mar. 13, 1967).

A verification of cavity formation in helium by exchange forces was demonstrated by measuring the lifetime of orthopositronium in the region of the transition from the free state to the cavity state. It is shown that these results are also applicable for cavity formation by electrons in helium. (auth)

16799 ELECTRON GUNS FOR THE INVESTIGATION OF COMPLEX CONFIGURATION MAGNETIC FIELDS. Akshanov, B. S.; Sebko, V. P. Prib. Tekh. Eksp., No. 6, 133-6(Nov.-Dec. 1966). (In Russian).

Application of electron gun methods for construction of magnetic systems and plotting complex field configurations in magnetic traps are discussed. The construction of electron guns used in the method is described. (tr-auth)

16800 MUONIUM. Hughes, Vernon W. (Yale Univ., New Haven). Annu. Rev. Nucl. Sci., 16: 445-70(1966).

The energy eigenstates and decay characteristics of muonium are discussed along with the following: experiments which establish the formation of muonium, experiments on the hyperfine-structure interval of the ground state of muonium, muonium interactions with other atoms and molecules, and the state of knowledge about a possible weak interaction which could lead to a conversion of muonium to antimuonium. (M.O.W.)

16801 UNRESTRICTED PROJECTED HARTREE–FOCK SOLUTIONS FOR TWO-ELECTRON SYSTEMS. Bunge, Carlos F. (Univ. of Florida, Gainesville). Phys. Rev., 154: 70-9(Feb. 5, 1967).

The singlet and triplet projections of a two-electron unrestricted Slater determinant (USD) are obtained. Then the S, Σ_g^+, etc., projections are considered and a correspondence is found between these functions and those that arise from a special choice of superposition of configurations. In the atomic case (S states), if the variation method is applied to a specific multiconfiguration wave function, one can readily obtain the corresponding USD, which is the Roothaan-type solution to the unrestricted, projected Hartree–Fock equations for that case, in a basis $\{R_{i|m|}(r)Y_{lm}(\theta\phi)\xi_{ms}(\sigma_s)$, i = 1, ...4 i = 1, ...8 when m ≠ 0); l = 0, 1, ... ∞; m = −l, ... l, $m_s = \pm 1/2\}$. Similar results are found for even-P states ($L_z = 0$), Σ_g^+ and Σ_g^- states. This applies to the ground state as well as to the excited states of the same symmetry type. In this way a value better than E = −2.9030 atomic units may be obtained for the nonrelativistic ground-state energy of the He atom, which means that more than 98% of the correlation energy can be accounted for by a single unrestricted projected Slater determinant. The quantitative effect of the use of spin-mixed spin orbitals is discussed, as well as some problems arising in the theory of unrestricted projected Hartree–Fock equations as applied to excitation processes. The use of a multiconfigurational form of the wave function constitutes only an artifice, and the unrestricted projected Hartree–Fock scheme at the present moment does not represent a reasonable approach to the two- and many-electron problems. Nevertheless, the present results indicate that it may become an alternative worthy of investigation. (auth)

16802 RELATIVISTIC SELF-CONSISTENT-FIELD THEORY FOR CLOSED-SHELL ATOMS. Kim, Yong-ki (Univ. of Chicago). Phys. Rev., 154: 17-39(Feb. 5, 1967).

The relativistic Hartree–Fock–Roothaan equation for closed-shell configurations of atoms is derived. The relativistic Hamiltonian consists of the sum of the Dirac Hamiltonians and the interelectronic Coulomb repulsion terms. The atomic wave function is assumed to be an antisymmetrized product of 4-component orbitals whose radial functions are expanded in terms of the Slater-type basis functions. The Breit interaction operator is used as the relativistic interelectronic interaction term, and is treated as the first-order perturbation. Expressions for the matrix elements of the Breit interaction operator are given for the closed-shell configurations. Numerical results for the ground states of He, Be, and Ne atoms computed according to this formalism are also presented. (auth)

16803 MEASUREMENT OF MUON (2p–1s)-TRANSITION ENERGIES IN ATOMS FROM SULFUR TO CHROMIUM. Budyashov, Yu. G.; Zinov, V. G.; Konin, A. D.; Mukhin, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 134-9(Jan. 1967). (In Russian).

The (2p–1s)-transition energies of negative muons in S, Cl, Ar, K, Ca, and Cr atoms were measured with the accuracy 0.3% using a NaI spectrometer. The results are in good agreement with the theoretical calculations. (auth)

16804 RARE-GAS COLLISION BROADENING IN THE LOWEST $^3P_1$ LEVEL OF Cd. Barger, R. L. (National Bureau of Standards, Boulder, Colo.). Phys. Rev., 154: 94-7(Feb. 5, 1967).

Alignment depolarization collision cross sections have been measured for the lowest $^3P_1$ level of cadmium broadened by the rare gases. Cross sections obtained with the Hanle effect (zero-field level crossing) and the method of modulated-light double resonance are the same within approximately 5%. They agree with theoretical predictions except in the case of helium, for which the measured cross section is nearly twice as large as the theoretical value. Average experimental values (units of 10^{-16} cm^2) for He, Ne, Ar, Kr, and Xe, respectively, are 51, 52, 81, 118, and 165. (auth)

16805 STATISTICAL TREATMENT OF IONIZATION IN ATOMIC COLLISIONS. Mittleman, M. H. (Univ. of California, Livermore); Wilets, L. Contract W-7405-eng-48. Phys. Rev., 154: 12-16(Feb. 5, 1967). (UCRL-14799).

A previously derived statistical model of atomic collisions is discussed and applied to the problem of ionization in the collision of two slow heavy atoms. The diffusion equation (in energy of excitation) resulting from the model is solved for a simplified nontrivial model. A universal curve is obtained for the cross section for single ionization. The experimental data of Lee and Gilbody are fitted remarkably well. (auth)

16806 MAGNETIC PROPERTIES OF Sc–Al ALLOYS. Chechernikov, V. I.; Pechennikov, A. V. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 120-1(May-June 1966). (In Russian).

Data on electronic leaf capacity and temperature dependence of magnetic suseptibility of metallic scandium indicated that, in the metal, d electrons are subjected to considerable collectivization. The state of d electrons in metallic scandium was studied using a Sc–Al alloy annealed for 60 hr at 600°C. The temperature dependence of magnetic suseptibility of alloys containing 66.7 and 85 at. % Sc was negligible. With increased content of Al the temperature dependence increased. Experiments also confirmed the collectivization of d electrons. (R.V.J.)

16807 TIME RESOLUTION OF LASER-INDUCED ELECTRON AND ION EMISSION. Kahn, S. H.; Richards, F. A.; Walsh, D. (Oxford Univ.). IEEE (Inst. Elec. Electron. Eng.) J. Quant. Electron., QE-1: 359-60(Nov. 1965).

The nature of the emission produced by a Q-switched ruby laser pulse focused on to a clean flat metal surface was investigated. The max laser energies used were 50 mJ as measured by a carbon cone calorimeter. The time duration of the pulse was 75 nsec. Electron emission was observed from a Ta target with the collector biased positive with respect to the target. For a laser input of ~50 mJ the electron emission formed 2 main peaks. The first peak occurred towards the end of the laser pulse and a second larger pulse came about 300 nsec later. If the laser output energy was reduced, not only did the emission decrease in amplitude but also in its form; the second peak disappeared. When ion emission was investigated with the collector biased negative with respect to the target, it again took the form of 2 distinct pulses; one pulse which occurred before the end of the laser pulse, and a second larger pulse about 1.5 msec later. The time at which the second ion pulse occurred was independent of the collector–target voltage in both instances. It is considered that the first electron emission peak is probably due to normal thermionic emission. The second and larger electron and ion pulses may be due to vaporization also. When the surface vaporizes, there is initially a very dense vapor cloud that subsequently spreads. Because the vapor is hot and dense there will be considerable numbers of ions and electrons formed by collision processes. The dispersion of these charged particles to the electrode of opposite sign may cause the second electron and ion emission pulse. The first ion emission pulse could only occur within the laser pulse duration if the initial ion energy was of the order 10^4 eV. This is improbable, and a more plausible explanation is that it is caused by a reverse photoelectric effect. (BBB)

16808 IONIZATION CURRENTS INDUCED BY ALPHA RADIATION IN LIQUID HEXANE AND HEPTANE. Chybicki, M. (Danzig Polytechnic). Acta Phys. Pol., 30: 927-31(Dec. 1966).

Results of measurements of the intensity of ionization currents induced by alpha particles from ^{239}Pu in hexane and heptane are presented. The effect of simultaneous ionization by alpha particles and gamma radiation from ^{137}Cs was investigated. The dependence of the ionization current on activity of the source of alpha radiation was found to be linear. (auth)

16809 COLLISIONAL EXCITATION TRANSFER BETWEEN HYDROGEN ATOMS. II. H(2S) + H(1S) → H(1S) + H(2S). Matsuzawa, Michio; Nakanura, Hiroki (Tokyo Univ.). Phys. Soc. Jap., 22: 392-8(Feb. 1967).

The cross-section for the exact resonance excitation transfer process H(2S) + H(1S) → H(1S) + H(2S), of which the interaction is a short range one, is calculated at energies of relative motion of 0.03, 0.1, 0.3, 1.0, 3.0, 5.0 and 10.0 eV by the perturbed stationary state method (PSS method). The interaction energies between hydrogen atoms are calculated by the Heitler–London method. The results are in good agreement with the results of the impact parameter method for energies of relative motion over 1.0 eV. The disagreement below 1.0 eV is due to the presence of the potential barrier in the $^3\Sigma_g$ adiabatic potential of the excited hydrogen molecule. The cross section calculated by PSS method is 33.1π au (atomic unit) at 0.03 eV. (auth)

16810 CORRELATION OF POSITRON LIFETIME WITH THE ANGLE BETWEEN ANNIHILATION GAMMA RAYS IN WATER AT ROOM TEMPERATURE. Puolakka, Heikki (Technical Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 218, 1-40(1966).

Experimental investigation of the correlation of positron lifetime with the angle between the annihilation gamma rays was carried out in water at room temperature. The possibilities of this kind of experiment are discussed, and a coincidence system constructed for this purpose is presented. The background contributions from various kinds of chance coincidence events were analyzed. In this analysis the deadtimes of the pulse height selectors and the pulse forming circuits were taken into account. The results show that owing to chance coincidence events the positron source activity must be limited to rather low values, and the counting rates are extremely low. With the coincidence system described, the ratio of chance to true coincidence rates is about 10^{-1} using a positron source with activity of 200 μCi when the positron lifetime distribution is measured in water with small angles ($0 < |\Theta| < 3{,}5$ mrad) between the annihilation gamma rays selected. In this case the counting rate of the true coincidences was found to be about 6,7 1/h. (auth)

16811 REGULARITIES OF SOFT EMITTER γ-FIELD DISTRIBUTION. Marenkov, O. S. At. Energ. (USSR), 21: 297-8 (Oct. 1966). (In Russian).

The integral intensity of inverse radiation scattering (according to the number of quanta) was calculated as a function of the source–detector distance. The calculations were made by the Monte Carlo method using the initial energies of the 0.279-MeV ^{203}Hg and 0.145-MeV ^{141}Ce γ sources; water, quartz, aluminum, and iron acted as scattering materials. The minimum source–detector distance was 3 cm and the maximum 25 cm; the statistical error in determining the integral flux for 16,000 quantum events did not exceed 2 to 3%. (R.V.J.)

16812 CERTAIN CHARACTERISTICS OF THE BACKSCATTERING FIELD OF γ-RADIATION INSIDE THE LABORATORY. Andryushin, N. F.; Bulatov, B. P.; Fradkin, G. M. At. Energ. (USSR), 21: 298-300(Oct. 1966). (In Russian).

Results of investigations using simulators showed that the factors of accumulation of energy from reflection (the ratio of the γ-energy flux density in the presence of a disperser and without it), $B_{re} = (J_p + J_0)/J_0$, increased with increase of the size of the cavity and reached maximum magnitudes equal to the accumulation from the reflection from the plane barriers with linear dimensions of more than 4 to 6 mean free path of primary radiation quanta in the wall materials. It was found that the spatial radiation distribution inside the cavity is practically isotropic (within 20 to 30%). Conditions similar to a real chamber 440 × 320 × 260 cm with 100-cm-thick concrete walls and operating with a strong γ emitter were checked using a mockup cavity with γ radiation sources (1.9 ± 0.1 μC ^{60}Co and 14 ± 0.7 μC ^{137}Cs) enclosed in 4 × 6 cm cylindrical ampules suspended in the center of the chamber. The results of measurements of the γ intensity as a function of the thickness of the lead filters at various distances between the detector and source are given in semilogarithmic scale. (R.V.J.)

16813 TOTAL CROSS SECTIONS FOR ELECTRON CAPTURE BY PROTONS FROM HELIUM INTO THE EXCITED 2s- AND 2p-STATES OF HYDROGEN. Dose, V. (Univ., Zurich). Helv. Phys. Acta, 39: 683-6(Dec. 30, 1966).

Relative total cross sections for the reactions $p + He \rightarrow H(2p)$ and $p + He \rightarrow H(2s)$ were measured in the energy range from 3 to 71 keV. The 2p-cross section has a maximum at 20 keV as found by other authors. The 2s-cross section shows a broad maximum at 40 keV and has a shoulder at 12 keV. The results are compared with the Born approximation predictions. (auth)

16814 STOPPING CROSS SECTION IN CARBON OF 0.1 TO 1.0 MeV ATOMS WITH $6 \leq Z_1 \leq 20$. Fastrup, B.; Hvelplund, P.; Sautter, C. A. (Univ. of Aarhus, Denmark). Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 10, 1-27(1966).

The stopping cross section, $1/N\ dE/dx$, in thin carbon foils was measured for ions, $6 \leq Z_1 \leq 20$, with energies from 100 keV to 1 MeV. The experimental data were corrected numerically for nuclear stopping to obtain the electronic stopping. The electronic stopping cross section has an oscillatory dependence on the atomic number, Z_1, for constant ion velocities. The analysis suggests that the relative amplitude of the oscillations decreases as the ion velocities increase. Apart from the oscillations, the experimental data are in reasonable agreement with the theoretical predictions. The relative accuracy of the measured data is about 2 to 3 percent, and the absolute accuracy of the evaluated electronic stopping cross section is better than 8 percent even in the most extreme cases (low energy and high Z_1). (auth)

16815 POSITRON ANNIHILATION IN COPPER, SILVER, GOLD, AND THALLIUM HALIDES. Cova, S.; Dupasquier, A.; Manfredi, M. (Politechnico, Milan. CNR, Milan). Nuovo Cimento (10), 47B: 263-9(Feb. 11, 1967).

A complex decay was found for positrons annihilating in Cu, Ag, Au, and Tl chlorides, bromides, and iodides. The time spectra are characterized by two components, with lifetimes about $2 \cdot 10^{-10}$ s and $4 \cdot 10^{-10}$ s. Their relative intensities, when summed, become nearly equal to 100% of the total number of counts, thus providing that none of these components can arise from the formation and decay of a positronium atom in ortho- and para-states. (auth)

16816 ABSOLUTE MEASUREMENTS OF TOTAL CROSS SECTIONS FOR THE SCATTERING OF LOW-ENERGY ELECTRONS BY ATOMIC AND MOLECULAR OXYGEN. Sunshine, Gabriel; Aubrey, Bertrand B.; Bederson, Benjamin (New York Univ.). Phys. Rev., 154: 1-8(Feb. 5, 1967).

The atom-beam recoil technique has been used to measure absolute total cross sections for the scattering of electrons by atomic and molecular oxygen at 22 energies between 0.5 and 11.3 eV, with additional data obtained up to 100 eV. In this method, a modulated electron beam cross-fires an atom beam, whose attenuation at the modulation frequency is observed. A mechanical chopper is utilized so that both the total atom beam and its scattered component can be measured by the same ac detection and amplification systems. It is therefore possible to determine absolute cross sections without requiring knowledge of the beam detection efficiency or the overall gain of the amplification system. The angular resolution in the electron polar scattering angle ranges from about 15.6° at 1 eV to 9.6° at 12 eV for O, and from about 18.5° at 1 eV to 11.4° at 12 eV for O_2. Our absolute values for O_2 between 0.5 and 11.3 eV are between 10 and 20% higher than those of Brüche, while the shape of the curve agrees well. The atomic cross sections vary from about 5.3 Å^2 at 0.5 eV to 8.3 Å^2 at 11.3 eV, with an estimated error of 20%, except for the 0.5-eV point, which has an error of 30%. These results are in excellent agreement with semiempirical calculations of Cooper and Martin and of Robinson and Geltman, as well as with the polarized-orbitals calculation of Temkin, and the static central field exchange approximation of Myerscough. (auth)

16817 SINGLE AND DOUBLE ELECTRON LOSS CROSS SECTION FOR 2- TO 50-keV H_1^- IONS INCIDENT UPON HYDROGEN AND THE INERT GASES. Williams, J. F. (Australian National Univ., Canberra). Phys. Rev., 154: 9-12(Feb. 5, 1967).

Direct determinations of the cross sections for single and double electron loss in single collisions by 2- to 50-keV H_1^- ions incident upon hydrogen molecules and inert-gas atoms are made by measuring the rate of growth of the fast-collision products, H_1^0 and H_1^+, with increasing target-gas number density. Previous measurements of $\sigma_{-1,0}$ have included contributions from $\sigma_{-1,1}$. It is shown that allowance for such contributions is only partially successful in improving the agreement between previously published values. (auth)

16818 ELECTRON IMPACT DISSOCIATION OF H_2^+. Dunn, Gordon H.; Van Zyl, Bert (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Phys. Rev., 154: 40-51(Feb. 5, 1967).

The absolute cross section for dissociation of H_2^+ by electron impact has been measured for electron energies between 10 and 1500 eV using a crossed-beam technique, which is described in some detail. The measured cross section can be represented by the function $\sigma = (1/E)\ (217 \log_{10} E - 184)$ where the cross section σ is in units of πa_0^2 and the electron energy E is in electron volts. Comparison is made with relevant theory, and the agreement between experiment and theory for the magnitude of the cross section is found to be surprisingly (and perhaps fortuitously) good. Within the limitations of both theory and experiment, agreement is found in the shape of the cross section as well. (auth)

16819 THEORY OF DISSOCIATION OF H_2^+ BY FAST ELECTRONS. Peek, James M. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 154: 52-6(Feb. 5, 1967).

Theoretical results for the dissociation of the hydrogen-molecule ion by high-energy electrons are considered with the intention of providing sufficient data for comparison with recent experimental studies of this system. The experimental results and this comparison are given in the preceding paper by Dunn and Van Zyl. The coefficients A and B for the cross-section formula $V_0^2 Q = A \ln V_0 + B$, where V_0 is the relative collision velocity, are given for the discrete transitions $1s\sigma_g - 2p\sigma_u$ and $1s\sigma_g - 2p\pi_u$ for each of the initial H_2^+ vibrational states in the $1s\sigma_g$ potential curve. Similar data, obtained from a closure argument, are given; an estimate of the remaining contributions to the experimental cross sections is then possible. (auth)

16820 FORBIDDEN PHOTO-IONIZATION AND ELECTRON SPIN POLARIZATION. Chiu, Lue-yung Chow (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 154: 56-60(Feb. 5, 1967).

A new mechanism involving normally forbidden processes, namely spin-dependent electric dipole and spin-dependent magnetic quadrupole transitions, is applied to the photo-ionization of atoms with a single ns outer electron. It is shown that, if the incident light is circularly polarized, the spin of the electrons ejected by these forbidden processes gets polarized along the direction of the light propagation as the axis of spin quantization. The cross section of photo-ionization by these transitions is shown to be at its maximum when the propagation vectors of the ejected electrons are parallel to the quantization axis, and is computed for the case of H, Li, and Na. This is in contrast to the spin-independent multipole transitions, where the cross section is zero for electrons ejected in that direction. The photo-ejected electrons are shown to be 100% spin-polarized when they propagate along the quantization axis. However, the spin polarization drops rapidly when the electron propagation vector deviates from that axis. This is illustrated by calculations on H, Li, and Na. (auth)

16821 EXCITATION TRANSFER IN HELIUM. Kay, R. B.; Hughes, R. H. (Univ. of Arkansas, Fayetteville). Phys. Rev., 154: 61-9(Feb. 5, 1967).

The apparent lifetimes of the n^1P, 3^1D, 4^1D, and 3^3D levels of helium are studied as a function of pressure. The collisional transfer of excitation from n^1P levels to nF levels is shown to be an important mechanism in populating D levels. It is found that

the Wigner spin rule inhibits collisional transfer between 4^1P and 4^3F levels. For $n > 4$, the n^1P transfer to n^3F levels is about three times greater than to the n^1F levels. For $n > 4$, the cross sections for collisional transfer from nF to n^1P levels are found to be about 10% of those for the reverse process. This result is in agreement with the principle of detailed balance. The collisional $n^1P \rightarrow nF$ transfer cross sections are measured and appear to increase approximately as n^4. The pressure dependence of the apparent 3D cross sections is calculated, using the above measurements in conjunction with the $n^1P \rightarrow nF$ transfer model. The results are found to be in excellent agreement with experimental measurements. (auth)

16822 MEASUREMENT OF CHARGE-EXCHANGE CROSS SECTIONS FOR H^+, H_2^+, AND He^+ IONS. Koopman, David W. (Univ. of Maryland, College Park). Phys. Rev., 154: 79-85 (Feb. 5, 1967).

Measurements have been made of the charge-exchange cross sections for the ion–molecule pairs: $H^+ + H_2$, $H_2^+ + H_2$, $H^+ + Ar$, $H_2^+ + Ar$, $H^+ + Kr$, $H_2^+ + Kr$, $H^+ + Xe$, $H_2^+ + Xe$, $He^+ + Ar$, $He^+ + Kr$, and $He^+ + Xe$ in the energy range of 70 to 1050 eV, employing electric fields in a collision chamber to collect slow ion-collision products. The present work generally confirms previous measurements, but shows larger values for low-energy cross sections of Kr and Xe, a systematic discrepancy that can be attributed to the design of the apparatus used in previous work. The present results are consistent with the predictions of the adiabatic theory and with reported observations of optical excitation of the heavy rare gases by low-energy helium-ion charge-exchange processes. (auth)

16823 CLASSICAL THEORY OF COLLISION-INDUCED ABSORPTION IN RARE-GAS MIXTURES. Levine, Howard B.; Birnbaum, George (North American Aviation Inc., Thousand Oaks, Calif.). Phys. Rev., 154: 86-92(Feb. 5, 1967).

Collision-induced far-infrared absorption has been observed experimentally in several rare-gas mixtures. A theoretical calculation of these spectra is carried out using classical radiation theory to determine the emission spectrum and converting to absorption via Kirchhoff's law. By using a simple empirical form to describe the variation of the collision-induced dipole moment with internuclear separation and by assuming straight-line collision paths, an analytic expression that agrees with experiments is obtained for the spectrum. Several elementary integrations permit analytical computation of the correlation function, relaxation time, static dielectric constant, and other invariants of the spectrum. (auth)

16824 BREMSSTRAHLUNG EMISSION FROM LOW-ENERGY ELECTRONS ON ATOMS. Mjolsness, R. C.; Ruppel, Hans M. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 154: 98-109 (Feb. 5, 1967). (LA-DC-7713).

General expressions are given for the bremsstrahlung cross section resulting from electron–neutral-atom collisions at energies comparable to or lower than the excitation energies of the atom and for the bremsstrahlung emission from an electron–neutral-atom gas. These quantities have been evaluated for oxygen and nitrogen, and appear to be consistent with shock-tube data. Electron scattering is treated by Hartree–Fock equations that contain neutral-atom bound orbitals and a semiempirical polarization potential. Elastic-scattering data are fitted by the adjustment of a single parameter in the polarization potential. The bremsstrahlung cross section is derived from a distorted-wave theory. The dipole-acceleration form of the matrix element is used for numerical convenience. Because each angular-momentum state has different direct and exchange potentials, the conventional bremsstrahlung formula must be generalized. Approximate analytical expressions for the bremsstrahlung cross section are also obtained from the dipole-length form of the matrix element. From two sorts of resonance phenomena exhibited by the bremsstrahlung cross section—one associated with maxima and minima in the elastic scattering, and one with the relative proportion of p-wave to s-wave scattering—it may be concluded that an accurate treatment of the electron scattering is necessary for the reliable prediction of bremsstrahlung. (auth)

16825 NEGATIVE-ION FORMATION IN H_2O AND D_2O. Compton, R. N.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 154: 110-16 (Feb. 5, 1967). (ORNL-P-2479).

The electron swarm-beam technique was employed to determine the dissociative attachment cross sections for H_2O and D_2O. The formation of H^- from H_2O peaked at an energy, ϵ_{max}, equal to 6.5 ± 0.1 eV, and the cross section $\sigma_c(\epsilon_{max})$ for the process at ϵ_{max} was found to be 6.9×10^{-18} cm^2. For D^- from D_2O, ϵ_{max} was 6.5 ± 0.1 eV and $\sigma_c(\epsilon_{max})$ was 5.2×10^{-18} cm^2. Data on the formation of O^- from H_2O and D_2O are also presented. Interesting isotope effects in the cross section for the formation of H^- from H_2O and D^- from D_2O, and the relative ion yields of the three O^- peaks from H_2O and D_2O were observed and are discussed in relation to existing theories for dissociative electron attachment. Data are also reported for ion–molecule reactions occurring in H_2O and in H_2O–O_2 mixtures. (auth)

16826 ANGULAR CORRELATION IN THE HELIUM ATOM. White, Ronald J. (Univ. of Wisconsin, Madison). Phys. Rev., 154: 116-17(Feb. 5, 1967).

Schwartz has shown that if the wave function for the ground state of He is developed as a perturbation series in powers of $1/Z$ and if the first-order wave function is expanded in a series of Legendre polynomials in the angle θ between the position vectors of the electrons, the contribution of the P_l component to the second-order energy behaves as l^{-4} for large l. This same behavior is noted for a model atomic system. (auth)

16827 ATOMIC READJUSTMENT TO AN INNER-SHELL VACANCY: MANGANESE K X-RAY EMISSION SPECTRA FROM AN ^{55}Fe K-CAPTURE SOURCE AND FROM THE BULK METAL. Schnopper, Herbert W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 154: 118-23(Feb. 5, 1967).

A comparison is made between manganese $K\alpha_{1,2}$ and $K\beta_{1,3}$ x-ray emission lines with initial states produced (a) by electron bombardment (EB) of a metal anode at 13 and 15 keV and (b) by K capture (KC) in ^{55}Fe. The lines in each case have, within experimental accuracy, the same energy position, width, asymmetry, and relative intensity. The complex $K\beta'$ secondary structure on the low-energy side of $K\beta_{1,3}$ is also independent of the means of production of the initial state. It is argued that K capture leads to an essentially pure, single-hole, relaxed ground state and that the probability of multiple hole production is negligibly small. From the comparison of the spectra, it is concluded that upon the production of a K hole by a low-energy knockout process, the state formed with highest probability is the ground state for the system with a K hole, and that this state is formed in a time short compared to its lifetime. Differences between KC and EB spectra would exhibit the effects of either incomplete readjustment and/or multiple hole production. Various mechanisms leading to multiple hole production are qualitatively discussed in terms of previous experimental observations of emission and absorption spectra. (auth)

16828 MOBILITY OF ELECTRONS IN LOW-TEMPERATURE HELIUM GAS. Levine, James L.; Sanders, T. M. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 154: 138-49(Feb. 5, 1967). (TID-23266).

Experimental measurement of the mobility of photoelectrons in low-temperature helium gas is described. At the highest gas densities (near the normal boiling point) the mobility is lower than the value predicted by kinetic theory by four orders of magnitude. At intermediate density a transition region occurs, and at the lowest densities studied, the mobility approaches the kinetic-theory limit. A theoretical discussion of the interaction of a slow electron with a collection of helium atoms is given, and it is shown that at high density and low temperature a correlated ("bubble") state becomes thermodynamically stable. The theory predicts correctly the mobility at high density, the critical density at which the transition occurs, and the approach to the kinetic-theory value at low density. It does not, however, account for the details of the transition region. The observations, and their interpretation, provide strong support for the "bubble" model for electrons in liquid helium. (auth)

16829 UPPER AND LOWER BOUNDS TO EIGENVALUES BY THE PARTITIONING TECHNIQUE. Goscinski, Saul Osvaldo. Gainesville, Fla., Univ. of Florida, 1966. 165p.

Thesis.

Some methods to obtain upper and lower bounds to energy eigenvalues and accuracy criteria for approximate wave functions are discussed. Particular emphasis is placed on the use of the partitioning technique as developed by Löwdin. Truncations of full and reduced resolvent operators are exploited, and the technique of inner projections of positive operators is used. Specific truncations led to inhomogeneous equations that were solved, thus obtaining explicit solutions to secular equations arising in the technique of intermediate Hamiltonians. Truncation of the reduced resolvent associated with the total Hamiltonian H led to the connection with the well-known Temple formula for a lower bound to the ground state, and the scheme may be implemented without resorting to explicit knowledge to E_1, the first excited state. This is achieved by obtaining lower bounds to the eigenvalues to PHP, i.e., the Hamiltonian in the space of the space P, associated with the reduced resolvent. The theory of reciprocal variational problems of Synge is applied to quantum mechanical perturbation theory, and upper and lower bound formulas due to Hirschfelder and Prager are derived within this geometric approach. Successive partitioning technique is applied in conjunction with truncations of T_0, the

reduced resolvent associated with H_0, the unperturbed Hamiltonian. This led to a new derivation of Feenberg's perturbation theory, showing the bracketing properties of the approximants, thus giving insight into the iterative method of solution for the Feenberg scheme as well as for continued fraction solutions for the eigenvalue problem of triple diagonal matrices. An eigenvalue transformation of the Schrödinger equation that leads to a positive Hermitian operator is discussed as an alternate path to obtain upper and lower bounds to atomic and molecular systems. For one-electron problems it gives a complete discrete spectrum; results of Walmsley on H_2^+, using a similar transformation are compared with those of Coulson and Johnson, using the conventional Bazley-Fox. Several formulas for the many-electron case of the transformed equation are given, as well as the explicit solution of the unperturbed problem which shows a peculiar interrelation among the quantum numbers labeling the one-electron states, suggested by Lundqvist. (auth)

16830 ENERGETIC AND ANGULAR STUDIES OF N_2D^+ AND ArD^+ FORMATION. Doverspike, Lynn Dale. Gainesville, Fla., Univ. of Florida, 1966. 88p.

Thesis.

The reactions $Ar^+ + D_2 \rightarrow ArD^+ + D$ and $N_2^+ + D_2 \rightarrow N_2D^+ + D$ were studied with an angular ion scattering apparatus at ion laboratory energies in the range 2 to 100 eV. Kinetic energy distributions as well as angular distributions of the product ions were determined. The experimental method consisted essentially of directing a well collimated, mass analyzed, and energy selected ion beam into a scattering region, and analyzing the product ions with a radio-frequency mass filter and a 127° electrostatic velocity selector. The product ion analysis and detection system rotate about the center of the scattering region, thereby giving information as to the angular distribution of the product ions. It was found that the observed Q values for these reactions (where Q is the energy transformed from internal to translational) depend on the primary ion kinetic energy. The Q values for both reactions are endothermic over the entire energy range of experiments, and show a marked dependence on collision energy. The product ion kinetic energy distributions also give evidence of back scattering in the center of mass system. The energetic and angular features of both reactions are essentially the same, indicating that the collision mechanisms leading to the formation of both product ions do not differ significantly. (Dissertation Abstr.)

16831 PROCEEDINGS OF THE EIGHTH ANNUAL ELECTRON AND LASER BEAM SYMPOSIUM, APRIL 6–8, 1966. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966. 527p. (CONF-660426).

Separate abstracts were prepared for 5 of the included 28 papers. One paper appeared previously in NSA 20: 37339. The remaining papers were not in the scope of NSA and hence omitted. (M.O.W.)

For abstracts of individual papers see: 16629 and 16832–16835.

16832 PRODUCTION AND USE OF MONOENERGETIC ELECTRON BEAMS. Simpson, J. Arol (National Bureau of Standards, Washington, D. C.). pp 437-47 of Proceedings of the Eighth Annual Electron and Laser Beam Symposium. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966.

The generation of dense electron beams of energy half-width below 0.1 eV presents special problems. Among these are generation of tightly collimated very-low-energy, space-charge effects in deflectors and anomalous energy spreads. A discussion of one successful attack on these problems is given together with examples of the use of such beams. (auth)

16833 MECHANISM OF ENERGY RELAXATION IN ELECTRON BEAMS. Ulmer, Kurt; Zimmermann, Bodo W. (Technische Hochschule, Karlsruhe, Ger.). pp 449-63 of Proceedings of the Eighth Annual Electron and Laser Beam Symposium. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966.

In electron beams with high charge density, anomalous shiftings are broadenings as well as symmetrizations of the energy distribution are observed. Continuing former work, where these phenomena were ascribed to a process which changes the energy distribution to a new equilibrium distribution, a corresponding mechanism is considered in greater detail and an apparent paradox is resolved. (auth)

16834 TECHNIQUES FOR THE STUDY OF SELF-FOCUSING ELECTRON STREAMS. Graybill, S. E.; Nablo, S. V. (Ion Physics Corp., Burlington, Mass.). Contract AF08(635)-5029. pp 465-86 of Proceedings of the Eighth Annual Electron and Laser Beam Symposium. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966.

A brief review is presented of the requirements of a relativistic electron stream such that self-magnetic (Bennett) confinement will occur. A description is given of a 4-MV pulsed electron field emission accelerator capable of generating kiloampere electron streams under well-defined conditions. Several techniques which have been used for the investigation of these high-current-density electron beams are reviewed. The thin film dosimetry and beam calorimetry techniques which have been developed to provide high-resolution mapping of a 17,000-A, 20-nsec stream are described and experimental data characteristic of accelerator performance are presented. (auth)

16835 QUEST FOR SUPERDENSE ELECTRON BEAMS. Waters, W. E. (Varian Associates, Palo Alto, Calif.). pp 487-504 of Proceedings of the Eighth Annual Electron and Laser Beam Symposium. Haddad, G. I. (ed.). Ann Arbor, Mich., University of Michigan, 1966.

In the theories of the steady flow of electrons, focused by a uniform magnetic field, which have been published to date it is shown that the electron plasma frequency ωp of the unrippled focused beam is related to the electronic cyclotron frequency ωh of the magnetic focusing field by the relation $\omega p = k\,\omega h$; one finds that k lies between $\frac{1}{2}$ and 1. An inquiry was made into the possibility that nature might permit operation of an axially symmetric system such that ωp can exceed ωh either somewhere, or throughout, the beam. The results of this inquiry are negative. The method of exploring the question is discussed. (auth)

Cosmic Radiation

Refer also to abstracts 16153, 16156, 16723, 16727, 16731, and 17001.

16836 (JPRS–38272, pp 17) ANALYSIS OF THE RESULTS OF MEASUREMENTS OF DOSES OF COSMIC RADIATION IN NEAR-EARTH SPACE. Akatov, Yu. A.; Kovalev, E. E.; Petrov, V. M.; Skvortsov, S. S.; Smirennyi, L. N. Translated from pp 15-16 of Problemy Kosmicheskoi Meditsiny: Materialy Konferentsii, May 24–27, 1966.

Measurements of doses of cosmic radiation made at altitudes of 200 to 400 km showed an average of about 16 to 20 millirad per day. The dose values agreed well with doses measured on the Vostok spaceship. The dose measurements were made with satellite-borne thermoluminescent integral dosimeter, chemical dosimeters, photodosimeters, and nuclear emulsions protected with different thicknesses of polyethylene, or, in the case of the thermoluminescent dosimeters, placed in filters made of Pb, Sn, or Cd. (C.H.)

16837 CALCULATION OF SOME CHARACTERISTICS OF EXTENDED AIR SHOWERS IN THE LOWER PART OF THE ATMOSPHERE FOR LARGE FLUCTUATIONS OF THE ELEMENTARY ACT. Nymmik, R. A.; Shestoperov, V. Ya. (Moscow State Univ.). Yadern. Fiz., 5: 357-68(Feb. 1967). (In Russian).

Some characteristics of extended air showers (EAS) are calculated assuming that the inelasticity coefficient and the multiplicity of the particles, produced in the interactions of protons with the nuclei of air atoms, vary considerably from case to case. The role of interactions with a large inelasticity coefficient in the development of EAS is considered. Results are given of calculations of the energy distribution of primary protons, generating EAS with a given number of particles, and of the energy flux in the electron–photon and the nuclear-interacting components of the EAS. (auth)

16838 RANGE STRAGGLING OF ULTRA-RELATIVISTIC MUONS. Castagnoli, Carlo; Picchi, Pio; Scrimaglio, Renato; Verri, Giuseppe. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 41: 56-64(July-Aug. 1966).

Previous limitations in the straggling problem for ultra-relativistic cosmic mesons (μ) are eliminated in the analysis presented. Particular attention is given to the energy losses due to nuclear effects. Fundamental processes and the calculation of the probability of meson (μ) underground survival using the Monte Carlo method are discussed.

16839 AZIMUTHAL ANGULAR DISTRIBUTIONS OF SECONDARY PARTICLES IN COSMIC JETS. Mishakova, A. P.; Nikolskii, B. A. Yadern. Fiz., 5: 150-2(Jan. 1967). (In Russian).

It is shown that the azimuthal angular distribution of particles in secondary jets, produced by neutral shower particles, is anisotropic. (auth)

16840 HELIOCENTRIC INTENSITY GRADIENTS OF COSMIC-RAY PROTONS AND HELIUM DURING MINIMUM SOLAR MODULATION. O'Gallagher, J. J.; Simpson, J. A. (Univ. of Chicago). Astrophys. J., 147: 819-27(Feb. 1967).

The preliminary results are reported of an experiment that measures the diffusion coefficient k and resolves the problem of the residual modulation at solar minimum. The intensity of cosmic protons and helium nuclei was measured as a function of energy or magnetic rigidity over a change in radial range $\Delta\gamma = 0.56$ au after correcting for time variations. From the observations the particle radial intensity gradient was determined as a function of magnetic rigidity and energy. The experiment was carried out on the Mariner IV spacecraft on its mission to and past Mars. (W.D.M.)

16841 UNSTABLE MAGNETOSONIC WAVES IN A RELATIVISTIC PLASMA. Lerche, I. (Univ. of Chicago). Astrophys. J., 147: 689-96(Feb. 1967).

Linearized equations are set up to describe the effect of a circularly polarized electromagnetic wave on a plasma composed of thermal electrons and protons and also containing an anisotropic relativistic proton component. The unperturbed composite plasma is taken to be imbedded in a homogeneous, uniform magnetic field and the wave is taken to propagate along the unperturbed magnetic field. For wave frequencies very much less than the electron cyclotron frequency it is shown that the relativistic proton plasma will be unstable provided only that $P_{||} \gtrsim P_{\perp}$, where $P_{||}$ and $P_{\perp}$ denote the relativistic plasma pressures parallel and perpendicular to the ambient magnetic field, respectively. The minimum e-folding time is estimated and upon inserting numerical parameters appropriate to the cosmic-ray gas in the galactic disk it is shown that parallel anisotropy ($P_{||} > P_{\perp}$) will be destroyed in a time short compared to the mean lifetime of cosmic rays in the disk ($\sim 6 \times 10^5$ years). (auth)

16842 COSMIC-RAY AIR SHOWERS. Suge, Koichi (Tokyo Univ.). Kagaku (Tokyo), 36: 290-7(June 1966). (In Japanese).

Recent studies of the showers in Japan are described. The course taken in the development of the neon photoscope and discharge chamber and typical methods for measurements of air showers are outlined. Air showers can be divided broadly into single-core, double-core, and mountain-range core. The measured results of horizontal air showers are also described, and their characteristics are treated from the interactions of μ mesons with other nuclei. (NSA of Japan)

16843 SPECTRUM OF COSMIC RAY PRODUCED NEUTRONS. Tajima, Eizo; Adachi, Minoru; Doke, Tadayoshi; Kubota, Shinzou; Tsukuda, Masahiro (St. Paul's Univ., Tokyo). J. Phys. Soc. Jap., 22: 355-60(Feb. 1967).

The spectrum of cosmic-ray-produced neutrons was measured between 1 and 10 MeV as a function of altitude. The detectors used were organic liquid scintillators to which a pulse-shape-discrimination technique was applied to select pulses of recoil protons. The proton spectrum was converted to the neutron spectrum by making use of the response function of the detectors. The best fit of the neutron spectrum between 2 and 10 MeV is $\phi_n(E_n) = 0.30 \exp(-0.0046x)E^{-0.0010x-0.77}$ neutrons cm^2/sec MeV, where x is an altitude in g/cm^2. The flux of neutrons of the same range of energy is dependent on altitude as $\exp(-0.0063x)$ in a good approximation. (auth)

Direct Energy Conversion

Refer also to abstract 16967.

16844 ELECTRICAL CHARACTERISTICS OF LINEAR HALL AND FARADAY GENERATORS AT SMALL HALL PARAMETERS. Zauderer, Bert (General Electric Co., King of Prussia, Pa.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 575-81(Mar. 1967).

Experiments were performed to determine the electrical characteristics of the linear, segmented-electrode, Hall and Faraday MHD generators. The generator working fluid was shock-heated xenon at 7000°K gas temperature, 1 atm pressure, equilibrium conductivity of 850 mho/m, and a Hall parameter that ranged in value from 0.7 to 2.5. The study was performed with and without magnetically induced ionization effects in the generator. If the electrode voltage losses were included in the data analyses, the Faraday generator transverse load characteristics were in agreement with the theory of Hurwitz, Kilb, and Sutton. If the voltage losses at the Hall current electrodes were included in the data analyses, the Hall generator load characteristics obtained under equilibrium plasma conditions were in agreement with the theory of Dzung. In the presence of magnetically induced ionization, the open-circuit Hall voltage and the Hall load characteristics were, on the average, 30 and 10%, respectively, below the theoretically predicted values. The Hall output reduction is attributed to plasma nonuniformities caused by gasdynamic forces, Lorentz forces, and nonuniform, magnetically induced ionization effects. However, it was not possible to determine which of these three loss mechanisms was dominant. It is concluded that in an experiment, in which a relatively small electrode gap is utilized, the primary cause of reduction in the power output is electrode voltage losses. (auth)

16845 ELECTRONIC SPACE-CHARGE NEUTRALIZATION IN A THERMIONIC CONVERTER. Chiplonkar, V. T.; Desai, S. K. (Inst. of Science, Bombay). Proc. Indian Acad. Sci., Sect. A, 64: 338-44(Dec. 1966).

The V–I characteristics and the space distribution of electron density, temperature, ion density, etc., were studied in a thermionic converter using dc excitation and rf excitation for the auxiliary discharge in blue argon. The latter was found to give higher yields. Higher yields were also obtained when the rf signal was allowed to leak into the interaction space of the device. It is shown that Ramsauer scattering accounts for a major part of the resistivity of the device. (auth)

16846 POSSIBLE FORMS OF DIRECT ENERGY CONVERSION. Kluge, Werner (Technische Hochschule, Stuttgart). Z. Angew. Phys., 22: 353-65(Mar. 1967). (In German).

The history, physics, and state of development of direct energy conversion are considered, i.e., the generation of electrical energy from different modes of energy avoiding mechanical energy. This field of research has grown increasingly important within the past ten years. Thermoelectric, thermionic, magnetohydrodynamic and photoelectric conversion, nuclear energy conversion from decay of radionuclides, and finally conversion of chemical in electrical energy have been discussed. The emphasis is placed on the physics of conversion. Hereby the limitations, especially of the efficiency of the different conversion methods are shown. Technical applications are discussed in essential aspects only. (auth)

16847 OXYGEN AS A BENEFICIAL ADDITIVE IN CESIUM THERMIONIC ENERGY CONVERTERS. Levine, Jules D. (RCA Labs., Princeton, N. J.); Gelhaus, Floyd E. J. Appl. Phys., 38: 892-3(Feb. 1967).

Pure oxygen was successfully diffused directly into the interelectrode space of several operating thermionic converters in a controlled and beneficial manner by using a semipermeable silver membrane as the electron collector. Typically, 1 to 100 monolayers of O_2 were diffused through the collector and the initial change in the voltage–current characteristics occurred 30 to 60 sec later. The results of earlier tests have already been reported, and supporting findings of more recent tests are presented. (W.D.M.)

16848 EFFECTS OF ELECTRON AND PROTON IRRADIATION ON THIN FILM SOLAR CELLS. Loferski, Joseph J. (Brown Univ., Providence). Rev. Phys. Appl., Suppl. J. Phys., 1: 221-7(Sept. 1966).

The reasons for interest in irradiation effects on solar cells are reviewed. It is shown that studies of these effects (a) permit estimates of the useful life of solar cells in space radiation fields, (b) provide information about the nature of the photovoltaic effect in specific kinds of cells, and (c) can lead to fundamental information about radiation effects in the parent material. Studies of radiation damage in GaAs, CdS, and CdTe are reviewed. Published data on damage to thin film cells is also reviewed. According to the literature, only protons have been shown to produce damage in the cells. This observation is shown to be in rough agreement with radiation damage theory. (auth)

Fluid Physics

Refer also to abstract 16923.

16849 (LA-3614) THEORETICAL AND EXPERIMENTAL TWO-DIMENSIONAL INTERACTIONS OF SHOCKS WITH DENSITY DISCONTINUITIES. Mader, Charles L.; Taylor, Roger W.; Venable, Douglas; Travis, James R. (Los Alamos Scientific Lab., N. Mex.). Aug. 1966. Contract W-7405-eng-36. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The "PHERMEX" radiographic facility was used to study the interaction of shocks with cylindrical aluminum rods, "V" notches, and cylindrical voids in water. The experimental results are compared with two-dimensional numerical PIC (particle-in-cell) computations. Agreement between computation and experiment was within the resolution of the methods. (auth)

16850 NONISENTROPIC TWO-DIMENSIONAL MHD FLOW. II. Gundersen, Roy M. (Univ. of Wisconsin-Milwaukee, Milwaukee). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 603-4(Mar. 1967).

Equations governing the two-dimensional steady flow of an ideal,

inviscid, prefectly conducting compressible fluid subjected to an applied magnetic field are given. (J.H.M.)

16851 SOURCE MODEL FOR PREDICTING THE DRAG FORCE ON A MOVING ARC COLUMN. Otis, David R. (Univ. of Wisconsin, Madison). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 582-4(Mar. 1967).

A source model is proposed to describe the behavior of an arc column in a crossflow. The drag force on the arc column is found to be $D = qU_\infty/c_pT_\infty$, where q = joule heating per unit length, U_∞ = freestream velocity, c_p = specific heat, and T_∞ = freestream temperature. When the drag force is balanced by a Lorentz force arising from an externally imposed magnetic field, the source model yields a relationship between crossflow Mach number and magnetic field which is in good agreement with experimental data for $M_\infty < 0.3$. (auth)

16852 ONE-DIMENSIONAL MAGNETOGASDYNAMICS. Kaul, C. N. (Iowa State Univ., Ames). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 591-2(Mar. 1967).

For one-dimensional magnetogasdynamical flows, relations between rates of propagation of constant pressure, density, specific entropy, and specific heats are established. Equations are given for the one-dimensional unsteady flow of an infinitely conducting polytropic gas, devoid of viscosity and thermal conductivity. (J.H.M.)

16853 EFFECT OF WALL CONDUCTANCE ON MAGNETOHYDRODYNAMIC FLOW THROUGH FINITE CROSS-SECTION CHANNELS. Gold, Richard R. (Hughes Aircraft Co., El Segundo, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.), J., 5: 539-44(Mar. 1967).

A detailed analysis of fully developed magnetohydrodynamic flow through rectangular and circular channels is presented for nonzero finite values of the uniform wall conductance ϕ. In particular, perturbation solutions are derived for small and large values of ϕ for the rectangular channel and for small values of ϕ for the circular geometry. These results are combined with existing exact and approximate calculations in a semigraphical procedure to obtain the ratio of mean velocity to pressure gradient as a function of arbitrary values of Hartmann number and ϕ. Specific consideration is given to the effect of wall conductance on this ratio, for both the rectangular and circular channels. Of particular interest is the substantial difference found between the results when $\phi \ll 1$ and the corresponding exact calculations for $\phi = 0$. (auth)

16854 SHOCK WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Lichnerowicz, Andre (College de France, [Paris]). Ann. Inst. Henri Poincare, Sect. A, 5: 37-75(1966). (In French).

The general properties of shock waves in relativistic magnetohydrodynamics were studied. The simplicity of the relativistic theory with respect to the classical theory is shown. The relativistic extension of the Hugoniot equation is formed. The equations of classical magnetohydrodynamic shock are deduced systematically from those equations corresponding to the relativistic framework. From the Hugoniot equation the signs of the principle thermodynamic variables of a discontinuity during the shock are studied. The simple properties of the Alfvén shocks make it possible to study more directly the compatability of a shock wave with the Alfvén wave. (J.S.R.)

16855 DIGITAL COMPUTATION OF THE FIELD OF AN ELECTROMAGNET FOR MAGNETOHYDRODYNAMIC RESEARCH. Fuller, F. L. (Grumman Aircraft Engineering Corp., Bethpage, N. Y.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 102-3 (Jan. 1967).

The nonlinear partial differential equation for the magnetostatic field with variable permeability is developed for the case in which the medium is discontinuous. These relations are converted to finite difference form and solved by means of a digital computer. The computer program and a sample problem are presented. (auth)

16856 HALL EFFECT ON THE MAGNETOHYDRODYNAMIC FLOW NEAR A STAGNATION POINT. Naruse, Humio (Tokyo Univ.). J. Phys. Soc. Jap., 22: 638-52(Feb. 1967).

In order to see the qualitative properties of the Hall effect in the magnetohydrodynamic flow past a body at large magnetic Reynolds number R_m and large Reynolds number R_e, the steady, incompressible flow near a two-dimensional stagnation point is studied on the assumption that a magnetic field is parallel to the velocity at infinity upstream and normal to the surface of the wall which is an insulator. For small values of the Hall parameter and pressure number series solutions are derived and the formulas for the local skin friction are obtained for $R_m/R_e \ll 1, = 1, \gg 1$. It is shown that the component of the skin friction, which is normal to the flow direction at infinity upstream, is positive or negative according as $R_m/R_e \gg 1$ or $\ll 1$, and the Hall effect produces little change in the skin friction for $R_m/R_e \sim 1$. (auth)

16857 INTEGRAL FORMULAS OF GREEN IN MAGNETOHYDRODYNAMICS. Agostinelli, Cataldo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 523-30(Apr. 1966). (In Italian).

The integral formulas of Green are generalized in the case of the spatial motion of a viscous incompressible electrically conducting fluid. Integral equations are established, which define the Cartesian components of the velocity, the total pressure (hydrodynamic and magnetic), and the components of the magnetic field at a point within a given dominion that is bounded by a closed surface, variable with time, and at a given instant. (auth)

16858 INVISCID STABILITY OF A MAGNETOHYDRODYNAMIC HALF JET. Deshpande, Narayan Vaman. Rochester, N. Y., Univ. of Rochester, 1966. 98p.

Thesis.

The stability of a magnetohydrodynamic half jet with an aligned magnetic field is examined. The steady-state investigation is formulated as a boundary layer problem for the case of infinite electric conductivity and finite viscosity. The effect of finite viscosity tends to relax the limitations of infinite conductivity because the current sheet is spread out over the boundary layer region. The procedure used in hydrodynamics to estimate the order of magnitude of various terms is extended to obtain the magnetohydrodynamic equivalent of Prandtl's boundary layer equations. Application of the von Mises transformation to these equations yields two coupled equations which give the velocity profile and the magnetic field configuration inside the boundary layer region. These equations are solved numerically for incompressible as well as compressible flows. In the incompressible case, with boundary conditions at infinity, it is known that the boundary layer thickness increases as the magnetic field is increased and finally the flow ceases when the magnetic pressure is equal to the kinetic pressure. In the compressible case it is found that for a given Mach number the boundary layer thickness increases for increasing magnetic field and the limiting value of the magnetic field is less than that in the incompressible case. A small perturbation is superimposed on the steady-state solution and the linearized inviscid disturbance equations are obtained. The inviscid stability of an incompressible flow with respect to a three dimensional disturbance is considered in detail. It is shown that the magnetic field introduces new singularities which approach to those of the Orr–Sommerfeld equation for vanishingly small magnetic field. The disturbance equation is solved numerically to determine the eigenvalues for a neutrally stable disturbance. It is concluded that the magnetic field has a stabilizing effect on the flow, however, no complete stability is attainable. It is proposed to investigate the inviscid stability of a compressible flow for subsonic as well as supersonic disturbances. To this purpose, the stability equation is derived, the singularities of this equation are discussed and a method of solution, similar to that in the incompressible case, is formulated. A few neutrally stable eigenvalues are determined. A definite conclusion awaits further calculations. (Dissertation Abstr.)

Geophysics

Refer also to abstracts 16038, 16722, 16724–16726, and 16728–16730.

16859 THE AGE OF THE EARTH, HEAVY ELEMENTS, AND METEORITES. Baranov, V. I. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Soviet Astron. AJ (Engl. Transl.), 10: 860-4(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 1074-80(Sept.-Oct. 1966).

A survey is given of the results of applying radioactive-decay age determinations in establishing an absolute age for the earth, chemical elements, and meteorites. The value $\approx 4.5 \times 10^9$ yr given by the isochrone method for the formation epoch of the earth and meteorites is realistic only if the earth and meteorites were formed simultaneously through differentiation of common protoplanetary material. An upper limit on the earth's age is given by the age of heavy chemical elements, and is evaluated by comparing the present and initial uranium isotope ratios $^{235}U/^{238}U$. A semiempirical estimate of ≤ 1.64 for the initial ratio corresponds to a uranium age of 6.6×10^9 yr. An upper limit on the age of the earth's crust can be estimated from the time required for radiogenic lead isotopes to accumulate to the current crustal abundance. This period depends on the lead/uranium ratio; a ratio of 33, corresponding to deep rocks, yields 7.5×10^9 yr as a limiting age for the crust. Thus recent reports of an age $>6 \cdot 10^9$ yr for terrestrial rocks and meteorites are not implausible. Further study of the age of the earth is needed. (auth)

16860 MOTION OF MAGNETIC FIELD LINES. Stern, David P. (Goddard Space Flight Center, Greenbelt, Md.). Space Sci. Rev., 6: 147-73(Nov. 1966).

The definition and applications of the motion of magnetic lines of force are reviewed and illustrated. The concept of such a motion is introduced as an aid to describing the evolution of a known magnetic field. It is shown that a known velocity field in a perfectly conducting fluid with embedded magnetic field may be regarded as describing the velocity of the magnetic field lines. The consequences of such a flow on the field are derived, including the properties of flux and line preservation and Cauchy's general solution. The discussion is extended to fluids having a finite high conductivity, with accent on the role of X-type neutral points in the magnetic field. Existing theories on the behavior of such neutral points are described. (auth)

16861 APPLICATION OF IMAGE ORTHICON TECHNIQUES TO AURORAL OBSERVATION. Davis, T. Neil (Univ. of Alaska, College). Space Sci. Rev., 6: 222-47(Nov. 1966).

The relatively high quantum efficiency of the photocathodes now used in photoelectric devices is an essential feature which makes these devices attractive for use in astronomical and auroral observations. In addition to possessing high sensitivity by virtue of the photocathode, certain types of photoelectric devices allow an image to be accumulated over some increment of time and then be read out in the form of an electrical signal which can be processed directly or used to produce a 2-dimensional image. One of these devices, the image orthicon television tube, has been found to be quite useful for obtaining auroral photographs and auroral and airglow spectra of very short exposure. (auth)

16862 A REVIEW OF IONOSPHERIC F REGION THEORY. Rishbeth, H. (Science Research Council, Slough, Eng.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 16-35(Jan. 1967).

Types of data which concern ionospheric F-region theory are reviewed. The physical processes which are believed to control the variations of electron density in the F1 and F2 layers are discussed. Possible explanations of several F region phenomena are presented, together with a brief consideration of magnetic storm effects. (auth)

16863 TEMPORAL VARIATIONS OF THE SPORADIC E LAYER AT SODANKYLAE. Oksman, J. (Geophysical Observatory, Finnish Academy of Science and Letters, Sodankylae). Ann. Acad. Sci. Fenn., Ser. A VI, No. 216, 1-10(1966).

Diurnal, seasonal, and sunspot cycle variations of the critical frequency of the sporadic E layer at Sodankylä were studied. In the diurnal variation, two maxima were observed, one at noon and the other around midnight. As these maxima are characteristic of temperate zone and auroral zone sporadic E, respectively, Sodankylä seems to be located in an intermediate zone where the effects of both neighbor zones are observed. The strong influence of the temperate zone at Sodankylä is seen also in the yearly variation of the ordinary critical frequency (foEs). The noon and midnight medians show pronounced summer maxima. A fairly clear positive correlation of the noon and midnight medians with the sunspot number was observed during the declining part of sunspot cycle No. 19. The variation of foEs was studied also by means of isocontour plots (time maps) using two threshold frequencies, 3 and 5 MHz, and a new type of map was obtained. (auth)

16864 ENERGETIC PARTICLES IN THE EARTH'S MAGNETIC FIELD. Anderson, Kinsey A. (Univ. of California, Berkeley). Annu. Rev. Nucl. Sci., 16: 291-344(1966).

The theory of motion of charged particles in magnetic fields is discussed. Experimental methods employed in measuring electrons and protons in the radiation zones of the earth are reviewed. Examples of detectors and detector characteristics used in satellite studies of trapped particles are described. Information is included on the structure of the interplanetary magnetic field, properties of solar wind, configuration of the earth's magnetic field, Van Allen radiation, stable trapping zone, particle fluxes in the outer radiation zone, and the precipitation of particles into the atmosphere. (J.H.M.)

16865 INTRODUCTION TO GEOPHYSICAL MAGNETOHYDRODYNAMIC RESONANCES. Radoski, Henry R. (Boston Coll., Weston, Mass.). Amer. J. Phys., 35: 128-32(Feb. 1967).

Resonance of a confined plasma magnetized by a dipole field is a fundamental geophysical problem which, except for special cases, remains unsolved. As an introduction to the equations, formalism, and concepts to be encountered in the more difficult dipole case, the problem of resonance in a plasma magnetized by a monopole or, in general, radial magnetic field has been solved. The magnetohydrodynamic wave equation is derived, and its plane wave solutions are indicated. For the case of a radial magnetic field, both axisymmetric and nonaxisymmetric solutions are obtained. Finally, the concept of vibrating magnetic-field lines is derived and discussed. (auth)

16866 ENHANCEMENT OF Li I LINE (6708 A) IN THE TWILIGHT AIRGLOW DUE TO THERMONUCLEAR EXPLOSION. Ghosh, S. N. (Allahabad Univ., India); Mitra, Ved. Ann. Geophys., 22: 609-13(Oct.-Dec. 1966).

A description is given of the enhancement in the intensity of Li I resonance line $^2P-^2S$ (6708 Å) in the twilight airglow of the upper atmosphere, attributed to thermonuclear explosions, and an attempt is made to explain the mechanism of this phenomena. It is suggested that the enhancement is due to the artificial production of Li atoms. It is proposed that at first ^7Be atoms are produced within the fireball of the explosion which subsequently spread out and at the same time decay into ^7Li atoms. They then react with atmospheric oxygen producing excited Li atoms in a manner similar to those for Na atoms in the upper atmosphere. By treating these reactions as first order, instantaneous concentration of Li atoms and hence the expression for the enhanced intensity of lithium line was obtained. Its time variation was shown to resemble the observed variation. Deviations which appear at the beginning and at the end of the curve are accounted for. The theoretical intensity-vs-time curve was computed, assuming A_0 (the initial concentration of ^7Be atoms) to be constant throughout the period of enhancement of the Li I line at the observing station. However, at a distant station, the constant value of A_0 is established a few days after the explosion, because artificially produced ^7Be atoms take time to reach full strength at the observing station. This would cause a slight shift initially of the theoretical curve in the forward direction. Moreover, the equilibrium among the various products of ^7Be atoms in the atmosphere above the observing station is constantly affected by diffusion. This effect would become more pronounced near the end of the period of enhancement and hence the rate of decay of the enhanced intensity would be faster than expected from the theory. (BBB)

16867 NEARLY MONOENERGETIC ELECTRON FLUXES DETECTED DURING A VISIBLE AURORA. Albert, Richard D. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 369-72 (Mar. 6, 1967).

Low-energy (3 to 70 keV) electron spectra were measured (Sept. 16, 1966, 0253 UT) during a visible aurora at Fort Churchill, Manitoba, using a relatively high-resolution electrostatic spectrometer as part of the payload of a Nike–Tomahawk rocket. The results indicate that the monoenergetic character of the spectra appears to favor the interpretation that the electron energization results from an acceleration process involving electric fields. (W.D.M.)

16868 EXCITATION OF THE N_2 FIRST POSITIVE SYSTEM IN THE AURORA. Shemansky, Donald Eugene. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1966. 267p.

Thesis.

The N_2 first positive system was observed in aurorae with a photoelectric spectrometer for the purpose of studying the excitation mechanisms. Pulse counting techniques and a memory unit for the accumulation of spectra were employed. The system appears to be excited mostly by direct excitation of ground-state molecules by electrons. There is evidence that other processes take place as well. Systematic variations in the relative vibrational populations of the B^3_g state, as a function of auroral height, were observed. These variations apparently cannot be explained by variations in cascade from higher states or by variations in the auroral electron distribution function. The relative vibrational populations in the lower levels of the B^3_g state appear to be too great to be accounted for by electron excitation. A number of processes that may affect the population of the B^3_g state were considered. No single process appears to give a satisfactory explanation of the observations. Rotational temperature measurements of the N_2 first positive system were made possible by the use of synthetic comparison spectra. The temperature measurements vary from about 250° to 700°K. The average intensities of the N_2 first positive, N_2 second positive, N_2^+ Meinel, and N_2^+ first negative systems in 1 BC 1 aurorae, were estimated. (Dissertation Abstr.)

16869 ULTRAVIOLET EMISSIONS OF THE AURORAE. Ahmed, Mukhtar. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1966. 193p.

Thesis.

The ultraviolet emission spectra of normal and sunlit aurorae were studied with a spectrograph giving a high dispersion of 20Å/mm and a resolution of the order of 1Å. The investigation was primarily concerned with the intensity distributions, temperatures and excitation mechanisms of the N_2^+ first negative, the N_2 Vegard–Kaplan and the N_2 second positive band systems. The spectra used are of a better quality than those available to previous workers.

An analytical method was developed, that is capable of evaluating the sunlit auroral content in a spectrum due to normal and sunlit aurorae. The application of this method, has shown varying degrees of fluorescence in the spectra studied. A good estimate of the temperature is obtained as a by-product of this method. The presence of the Swings effect and the nonradiative equilibrium of the N_2^+ ions with the exciting continuum in the sunlit aurorae were confirmed. The rotational structure of the Vegard–Kaplan bands of N_2 was successfully synthesized, and a better set of line strength factors for their synthesis is suggested. The rotational temperatures of the Vegard–Kaplan bands of N_2 determined from the observed spectra are in the range 900 to 2200°K. The close agreement between the N_2 Vegard–Kaplan temperatures and the N_2^+ first negative temperatures shows rotational equilibrium in the $A\,^3\Sigma_u^+$ state and, as a consequence, a longer lifetime as well. The variations in the relative populations of the vibrational levels of the $A\,^3\Sigma_u^+$ state have confirmed the operation of the cascading mechanism. The relative populations of the vibrational levels of the $C^3\pi_u$ state of the second positive system of N_2 were studied, and the question of the possibility of determining vibrational temperatures was examined. (Dissertation Abstr.)

16870 ELECTRON DENSITY PROFILES IN IONOSPHERE AND EXOSPHERE. Proceedings of the NATO Advanced Study Institute held at Finse, Norway, April 1965. Frihagen, Jon (ed.). New York, John Wiley and Sons, Inc., 1966. 641p. $18.75. (CONF-650458).

Many aspects of the problem of determining and understanding the state of the ionosphere and exosphere are discussed. Results are presented of advanced ground-based and rocket- or satellite-borne experiments that measured electron density profiles and physical properties related to the profiles such as composition, temperature, and motions of the atmosphere, solar radiation and particle influx, the state of the magnetosphere, and the variability of these quantities. Summaries are included of the present status and suggestions for profitable future trends of research in some of the main areas of ionospheric physics. (J.H.M.)

Low-Temperature Physics

16871 (AD–642028) SUPERCONDUCTIVITY AND LONG-RANGE ORDERING IN A15-TYPE STRUCTURES. Van Reuth, E. C.; Waterstrat, R. M.; Blaugher, R. D.; Hein, R. A.; Cox, J. E. (Marine Engineering Lab., Annapolis, Md.). Sept. 1966. 13p. (MEL–458/66). CFSTI $3.00 cy, $0.65 mn.

Preliminary experiments indicate that there is a definite dependence of superconducting transition temperature upon the degree of atomic ordering in A15-type structures. Two new superconductors were discovered in the course of the experimental work: the stoichiometric composition Cr3Rh and the off-stoichiometric compound Cr72Os28 with transition temperatures of 0.06K and 4.03K, respectively. (auth)

16872 (AD–642104) ULTRASONIC ATTENUATION OF PURE STRONG-COUPLING SUPERCONDUCTORS. Woo, James W. F. (Rutgers–The State Univ., New Brunswick, N. J. Dept. of Physics, Cornell Univ., Ithaca, N. Y.). Nov. 1966. Contract Nonr-401(38). 29p. (TR–16). CFSTI $3.00 cy, $0.65 mn.

The low-frequency longitudinal ultrasonic attenuation of strong-coupling superconductors is discussed. The starting point is a formula due to Kadanoff and Falko which expresses the attenuation in terms of various correlation functions. These functions were evaluated in the ladder approximation. The results are valid for all values of ql (l-electron mean free path, q-phonon wave number). In the $ql \gg 1$ limit, the contribution of the density–density correlation function is dominant and Ambegaokar's result is obtained for the reduced attenuation (ratio of attenuation in superconducting to normal states). In the $ql \ll 1$ limit, all correlation functions are equally important. The reduced attenuation is a function of q and differs from the results of the BCS isotropic model. Numerical calculations for the reduced attenuation in lead was performed for various values of q which satisfies $ql \ll 1$. The results are in rough agreement with that of Deaton's experiment. (auth)

16873 (MIT–3700–1) HIGH CURRENT DENSITY SUPERCONDUCTING COILS. Williams, J. E. C. (Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.). Feb. 1, 1967. Contract AT(30-1)-3700. 18p. (CONF-660921-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Colloquim on Intense Magnetic Fields, Their Production and Their Application, Grenoble, France.

It is shown that, in a composite with steady-state stabilization, overall current densities can be obtained which are higher than the stabilized short-sample current density. These can be achieved at the expense of stabilized current. It was demonstrated that the function of metallic interleaving in a superconducting composite ribbon coil is probably largely thermal; that is, transient heat transfer to the metallic interleaving during the period of an instability maintains the temperature of the composite low enough for the recovery of superconductivity. The use of mylar as an insulation between the composite and the metal interleaving limits the heat transfer rate to a rather low value; 0.006-cm lead foil does not offer a comparable limitation to the thermal diffusion. It is expected that increased threshold currents could be obtained by the use of inorganic insulation on the ribbon and that thinner lead foil could be used to give higher overall current densities. (auth)

16874 (ORNL–TM–1721) EXPERIMENTAL SIMULATION OF LARGE, HIGH FIELD, SUPERCONDUCTING MAGNET OPERATION. Final Report, March 1, 1965–November 28, 1966. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 115p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The following work is reported: Tests with sample coils in external fields; theory and experiments with hard superconductor wire partly in normal, partly in superconducting state ("post quenching currents"); calculations and experiments with compound conductors (high field superconductors, both in the nonresistive and in the flux flow state, in close connection with metallic stabilizers); theory and experiments concerning the critical current of a hard superconductor in zero external field; tests on the influence of premagnetization on the quenching currents of an Nb–25% Zr wire; adiabatic flux jumps of high field superconducting cylinders in longitudinal fields; influence of the surface currents on the performance of cylindrical samples with slowly changing external fields; and flux scanning in the gap between two sections of a cylinder and in the midplane gap between two Nb–25% Zr wire wound coils. (auth)

16875 SPECIFIC HEAT OF SUPERCONDUCTORS WITH OVERLAPPING BANDS. Soda, Toshio (Tokyo Univ. of Education); Wada, Yasushi. Progr. Theoret. Phys. (Kyoto), 36: 1111-34(Dec. 1966).

The anomalously small jumps in specific heat, ΔC, of superconducting lanthanum and yttrium compounds are discussed in terms of Suhl, Matthias and Walker's theory of superconductivity in the case of overlapping two bands. It turns out that the law of corresponding states still holds in a generalized sense. The ratio between the jump and the electronic specific heat in the normal phase at the transition temperature, $\Delta C/\gamma T_c$, is a function of four independent quantities, although the theory contains five parameters. The ratio is found to be generally smaller than the BCS result, 1.43, for superconductors with a single conduction band. It is suggested that electron tunneling experiments could determine the two energy gaps at the absolute zero temperature and the ratio between them at the transition temperature, thereby providing sufficient knowledge to estimate the ratio. The experimental results for niobium and molybdenum are discussed. Niobium does not show such a small ratio and is suggested to have rather strong pairing interactions. Molybdenum is a weak coupling superconductor and has a small ratio $\Delta C/\gamma T_c$. In one of the appendices, a derivation is presented of the electron tunneling characteristics at nonzero temperatures, the time variation in the density matrix being explicitly taken into account. (auth)

16876 COEXISTENCE OF SUPERCONDUCTIVITY AND FERROMAGNETISM. Takano, Fumihiko (Tokyo Univ. of Education). Progr. Theoret. Phys. (Kyoto), 36: 1095-1110 (Dec. 1966).

The effect of the dynamic nature of impurity spins on the superconducting transition is studied in dilute alloys with the paramagnetic impurities, which are ordered ferromagnetically. Only the exchange interaction between electrons and impurity spins is considered, and by taking terms up to second order in this interaction, the possibility of coexistence of superconductivity and ferromagnetism is studied. The dynamical nature of the impurity spins is shown to have a rather large effect on the superconducting transition in the ferromagnetic state, and the coexistence of the two phases becomes possible at least for a ferromagnetic exchange interaction. (auth)

16877 SUPERHEATING AND SUPERCOOLING IN TYPE I SUPERCONDUCTORS: TIN. Smith, F. W.; Cardona, M. (Brown Univ., Providence). Phys. Lett., 24A: 247-8(Feb. 27, 1967).

The superheating and supercooling fields of unplated and copper-plated tin spheres are reported. The data suggest an increase in H_{c3}/H_{c2} with decreasing temperature. (auth)

16878 CRITICAL FIELDS H_{c2} AND H_{c3} OF THIN FILM TYPE-II SUPERCONDUCTORS. Rajput, J. S.; Gupta, A. K. (Univ. of Allahabad, India). Phys. Lett., 24A: 260-1(Feb. 27, 1967).

One dimensional Ginzburg–Landau equations are solved, using a Laplace transform method, and approximate analytical solutions are obtained. Critical fields H_{c2} and H_{c3} of thin-film type-II superconductors are calculated. (auth)

16879 SURFACE CURRENTS IN TYPE II SUPERCONDUCTORS. Gascon, F.; Lowell, J.; Munoz, J. S. (Oxford Univ.). Phys. Lett., 24A: 257-8(Feb. 27, 1967).

It is shown that the resistive behavior of an extremely ideal type II superconductor is strongly influenced by the surface. (auth)

16880 NATURE OF THE SUPERFLUID CRITICAL VELOCITY. Sarfatt, J. (Univ. of California, San Diego). Phys. Lett., 24A: 287-8(Feb. 27, 1967).

The Feynman backflow is generalized to include unsteady turbulent flows in the superfluid. Emission of real quanta of the self-consistent retarded backflow velocity field are the cause of the turbulent instability. (auth)

16881 SUPERHEATING FIELDS IN SUPERCONDUCTORS. Matricon, J. (Faculte des Sciences, Orsay, France); Saint-James, D. Phys. Lett., 24A: 241-2(Feb. 27, 1967).

The superheating field in superconductors was calculated as a function of the Ginzburg–Landau parameter κ. (auth)

16882 ENTROPY OF HYSTERETIC SUPERCONDUCTING STATES. Schweitzer, D. G.; Garber, M. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Lett., 24A: 255-6(Feb. 27, 1967). (BNL–10883).

An experiment is described, which shows that hysteretic superconducting states with the same values of H, M, and T have different entropies. The significance of the area of the closed loop in the M–H plane connecting these points is discussed. It is shown that if the area represents irreversible heating, the two states have the same free energy. (auth)

16883 VACUUM VAPOR DEPOSITION OF AN Nb_3Sn LAYER ON A WIRE. Arkharov, V. I.; Borisov, B. S.; Moiseev, A. I.; Ugol'nikova, T. A. (Inst. of Physics of Metals, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 170: 1303-5(Oct. 21, 1966). (In Russian).

To reduce the clogging of the reaction chamber by nonvolatile niobium trichloride, a new method and equipment for continuous deposition of a superconducting layer of Nb_3Sn on a moving wire has been developed. A wire is continuously fed through seals into a reaction chamber at a fixed speed. A portion of the wire is under treatment and is heated to about 1000°C by electric current fed through sliding contacts. The bottom part of the reaction chamber contains solid niobium pentachloride. The chamber is maintained at a temperature of 120 to 180° by an electric furnace controlled by a thermocouple. Vapors of niobium pentachloride proceed directly to the wire. Hydrogen passing through a reservoir kept at 0°C is saturated with vapors of tin tetrachloride and then passed through a pipe to the reaction chamber, where it comes in contact with the wire and forms a layer of Nb_3Sn on its surface. Waste gases are removed through another pipe. With this arrangement, the zone in which niobium trichloride can be formed is very small and a clogging of the reaction chamber was not observed. The unit was tested on platinum and nichrome wire 0.3 mm in diameter. The temperature of deposition was varied between 800 and 1200°C. A single-phase layer (1 to 4 μ thick) of Nb_3Sn with β W structure was obtained. It was established that the thickness of the layer increases with a temperature rise. (ATD).

16884 THE TUNNELING CRYOTRON: A SUPERCONDUCTIVE LOGIC ELEMENT BASED ON ELECTRON TUNNELING. Matisoo, J. (IBM Watson Research Center, Yorktown Heights, N. Y.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 172-80 (Feb. 1967).

The operation of a new superconductive logic element is discussed. In geometry, the element resembles the in-line cryotron and like the in-line cryotron exhibits gains of greater than unity when biased. The gate, however, is a Josephson junction. The two states, zero-voltage and "resistive," of the junction are both superconducting states, one being a pair tunneling state, the other a single-particle tunneling state. The transition from one state to the other takes place in less than 800 ps (the resolving time of the apparatus). If used in a flip-flop circuit in a current steering mode, current transfer times are calculated to be less than 200 ps. (auth)

16885 MAGNETIZATION OF AN IDEAL SUPERCONDUCTING TORUS IN A TRANSVERSE FIELD. Wright, Evan B.; Peterson, Paul I. (Naval Research Lab., Washington, D. C.). J. Appl. Phys., 38: 855-60(Feb. 1967).

The magnetic constants of an ideal superconducting torus, located in a uniform magnetic field perpendicular to its axis of symmetry, were calculated from a scalar potential expansion in toroidal Legendre functions. Graphs and approximate formulas are given for the induced magnetic moment of the torus and the maximum field values (with locations) on its surface, as functions of its radius ratio. (auth)

16886 PROBABLE UPPER LIMIT OF H_{c2} FOR SOME HIGHER-ORDER DUCTILE TRANSITION-METAL SUPERCONDUCTING ALLOYS. DeSorbo, W.; Lawrence, P. E.; Healy, W. A. (General Electric Co., Schenectady, N. Y.). J. Appl. Phys., 38: 903-4 (Feb. 1967).

A prime requisite for superconductors for high magnetic field applications is that the materials have a large upper critical field, H_{c2}. The dependence of H_{c2} on composition of some ternary and higher-order transition-metal alloys is examined. Although it is not yet possible to design alloys with the desired characteristics from first principles, it is shown that the solute-size–valence rule, recently proposed for transition-metal alloys, serves as a useful guide. The scheme defines the probable upper limit of H_{c2} for this family of alloys, including ternary and higher-order systems. (W.D.M.)

16887 TORQUE ON A SUPERCONDUCTING TORUS IN A UNIFORM FIELD. Wilson, B. J.; King, E. E. (Naval Research Lab., Washington, D. C.). J. Appl. Phys., 38: 745-52(Feb. 1967).

The torques of superconducting lead tori immersed in various uniform magnetic fields are calculated as a function of angular position and compared to measured values. The calculations, based on ideal superconducting behavior, are found to agree with experiment for the closed torus if persistent current decrease due to critical surface fields is taken into account. The recognition of trapped flux phenomena is needed to explain measured results for the open torus when it has been cooled in a nonzero field or when a magnetic transition to superconductivity has been made. The analytic model utilizes magnetic moments for a torus in an axial and in a perpendicular field, both having been calculated rigorously elsewhere. In addition, methods of obtaining approximations to these moments are presented because of their possible application to more general toroidal bodies. The total magnetic moment (and thus the torque) for arbitrary angular position is obtained by superposition, a result not heretofore available. (auth)

16888 SIZE EFFECT AND CRITICAL TRANSPORT CURRENT IN TITANIUM (22 AT. PERCENT NIOBIUM). McInturff, A. D. (Atomics International, Canoga Park, Calif.); Chase, G. G.; Whetstone, C. N.; Boom, R. W.; Brechna, H.; Haldemann, W. J. Appl. Phys., 38: 524-6(Feb. 1967). (SLAC-PUB–220).

The dependence of the critical transport current density on conductor size was measured for the superconductor, Ti (22 at. % Nb), in transverse fields up to 93 kG. For samples with as similar metallurgical histories as possible, it is found that the critical current is proportional to the cross-sectional area for samples 0.0024 to 0.0501 in. in diameter. More important, the field-dependence found for critical current densities is given by $J_c = A_0/b_0 \exp(-B/b_0) + C_0$, where B is the applied transverse magnetic field. (auth)

16889 OBSERVATION OF NAGAOKA'S BOUND STATE FOR CONDUCTION ELECTRONS IN DILUTE MAGNETIC ALLOYS. Daybell, M. D.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 18: 398-401(Mar. 13, 1967).

Recent theories differ as to whether a negative s-d exchange interaction between a localized-impurity moment in a dilute alloy and the conduction-electron spins will result in the formation below some critical temperature, T_c, of a quasibound state analogous to the Cooper pair in the theory of superconductivity or will merely cause a strongly temperature-dependent scattering of conduction electrons at low temperatures. Electrical resistivity measurements over the range 0.040 to 40°K are reported for dilute alloys of iron in copper which should permit a clear choice between the two predictions. (W.D.M.)

16890 SPECIFIC HEAT OF Nb–Zr ALLOYS AT LOW TEMPERATURE. Watanabe, Naoko. Denki Shikensho Iho, 30: 923-9(Nov. 1966). (In Japanese).

The specific heat of Nb and Nb–Zr alloys covering the entire range of bcc phase was measured at low temperatures. The electronic specific heat coefficient γ and the superconducting transition temperature T_c depend on the composition; the former shows a maximum value at Nb–15 at. % Zr. For this composition γ and T_c are 10.5 mJ/deg^2 mole and 10.8°K, respectively. Debye temperature θ_D depends on both the composition and the temperature, monotonically decreasing from 242 to 183°K as Zr concentration increases from 0 at. % to 75 at. % Zr. The measured values of T_c are in good agreement with those from the susceptibility measurement by C. K. Jones. (auth)

16891 NEW MEASUREMENTS OF THE ELECTROMAGNETIC ABSORPTION SPECTRUM OF SUPERCONDUCTING LEAD. Norman, Scott L.; Douglass, David H. Jr. (Univ. of Chicago). Phys. Rev. Lett., 18: 339-40(Mar. 6, 1967).

The observation of a "precursor" absorption in superconducting lead was previously reported [Phys. Rev. Letters 17: 875(1966)], which appeared as a double peak structure lying below the energy gap. Further work with the same equipment indicates that this structure was spurious and due to the unsuspected presence of higher order radiation in the beam of the monochromator. With this difficulty corrected, data were obtained and are plotted for the relative absorption of a 5900-Å lead film, showing no sign of any precursor. Similar results were obtained for three other films of thickness 1400, 600, and approximately 54,000 Å. (J.H.M.)

16892 STRONG-COUPLING SUPERCONDUCTIVITY IN GALLIUM. Cohen, Roger W.; Abeles, B.; Weisbarth, Gabriel S. (RCA Labs., Princeton, N. J.). Phys. Rev. Lett., 18: 336-9 (Mar. 6, 1967).

Gallium films were prepared which exhibited three distinct energy gaps: $\Delta_1 = 1.03$ mV, $\Delta_2 = 1.38$ mV, and $\Delta_3 = 1.53$ mV. The corresponding values of $2\Delta/k_BT_c$ were substantially larger than the BCS value of 3.5, indicating strong-coupling superconductivity. It is thought that the three energy gaps are those of three high-T_c modifications of Ga present in the films. The high Δ's can be accounted for by an increase in N, the density of electronic states at the Fermi surface, above that of ordinary Ga, which has the lowest value of N of all superconductive elements. The energy gaps were determined by means of tunneling measurements using Al-Al_xOy-Ga, Sn-Sn_xOy-Ga, and Ga-Ga_xOy-Pb junctions. (W.D.M.)

16893 NUCLEAR MAGNETIC RESONANCE IN SUPERCONDUCTING LEAD. Hines, William A.; Knight, W. D. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 341-2(Mar. 6, 1967).

Observation of the nuclear magnetic resonance of small platelets of lead in the superconducting state is reported. Measurements of the residual NMR shift were undertaken in samples of lead with average particle dimensions of 120, 270, and 410 Å. A residual shift of 83% for one sample and 60% for another was observed. The NMR line in the other sample was not seen. (W.D.M.)

16894 EVIDENCE FOR THERMODYNAMIC FLUCTUATIONS IN A SUPERCONDUCTOR. Parks, R. D.; Groff, R. P. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 18: 342-5(Mar. 6, 1967).

It is shown that a particularly favorable regime in which to study thermodynamic fluctuations is a superconducting microstrip in the presence of current flow. A qualitative model is sketched which predicts that thermodynamic fluctuations lead to an anomalous temperature dependence of the critical current near the superconducting transition temperature T_c, which is marked in a superconducting strip of small but readily obtainable dimensions. Preliminary experimental results on Sn microstrips are in qualitative agreement with the model. (W.D.M.)

16895 CUBIC SYMMETRY EFFECTS IN SOLID ^{3}He. Rosenwald, David (Univ. of California, San Diego, La Jolla). Phys. Rev., 154: 160-70(Feb. 5, 1967).

A detailed analysis is made of the single-particle model for solid ^{3}He at 0°K under an external pressure of 30 atm. The correct Hamiltonian being assumed, it is shown at the outset that the calculation gives a rigorous upper bound for the ground-state enthalpy of the system. The many-body wave function is taken to be a product of single-particle wave functions cubically symmetric about their respective lattice sites. In order to obtain the best product wave function of this type, the usual minimization principles are applied, and a set of self-consistent equations are obtained, which differ as expected from the spherically symmetric Hartree equations. These cubically symmetric equations are then solved numerically, and the ground-state energy obtained is 10% lower than that obtained in the spherically symmetric approximation. This result is still significantly higher than the probable experimental value. (auth)

16896 COMMON INTERPRETATION OF PHASE TRANSITIONS IN VARIOUS MODELS. Emch, Gerard G. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 8: 13-18(Jan. 1967).

A discussion is presented of the formal analogy which exists between the Bardeen-Cooper-Schrieffer (BCS) model for superconductivity and the several variations of the model suggested by Kac for the exact study of phase transitions. Some of the algebraic techniques, pioneered by Haag for his formulation of axiomatic field theory and his application of this theory to the BCS model, are shown to extend to all these cases. Some arguments are given to point out the necessity of a new interpretation of the existence of various phases in the same physical system. The results obtained so far for equilibrium situations confirm the consistency of the proposed tentative description of the phenomena considered. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 16749.

16897 (COO-1233-44) RELATED TECHNIQUES IN THERMONUCLEAR RESEARCH. Kerst, D. W. (Wisconsin Univ., Madison). Mar. 1, 1967. Contract AT(11-1)-1233. 12p. (CONF-670307-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Among the aspects of thermonuclear plasma research and accelerator technology which have common techniques and problems is the problem of injection which, in the case of accelerators, is guided by limitations imposed by the Liouville theorem. There are various examples of how this limitation on injection comes into play in the case of some plasma devices. There is an interesting analogy between the topology of phase space for particle accelerators and the topology of coordinate space for lines of force in a plasma containment device such as a toroidal stellarator. There are integral, ½-integral, ⅓-integral, ¼-integral, etc., resonances which can be stimulated by magnetic field errors in plasma-confining devices and which would cause the flux-plot topology to break up into rings of islands for a case where the flux plot has shear. The size of the islands depends upon the type of the multipole field forming the flux plot. Although stellarators are made with twisted or helical multipole windings wound around the major circumferential, they can also be made by sectored multipole magnets rotated between focusing and defocusing positions as in an accelerator. For the quadrupole case, the transfer matrices include only exponentials with real exponents and no sines and cosines such as are found in the accelerator analogy. (auth)

Confinement and Heating of Plasma

Refer also to abstracts 16799 and 17246.

16898 MOTION OF CHARGED PARTICLES IN AN ACUTE-ANGLE TRAP. Ershkovich, A. I.; Pletnev, V. D.; Skuridin, G. A. Dokl. Akad. Nauk SSSR, 170: 1290-1(Oct. 21, 1966). (In Russian).

It is shown that in a magnetic trap with opposing fields, where the summary magnetic field is given by $H_\rho = -A\rho$; $H_\varphi = 0$; $H_z = 2Az$, the equations of motion of a particle with mass m and charge e have, besides the solutions already obtained in other papers, also an exact particular solution corresponding to motion along the surface of the cone $\rho^2 = z^2$. Furthermore, trajectories which do not pass through the origin cannot lie on this cone. The time interval T required for the particle to cover the path from the vertex of the cone to the maximum value of z is also determined. The trajectory has a figure-8 form and the complete period of motion is equal to 4T. (ATD)

16899 NON-LINEAR THEORY OF MOTION OF FAST CHARGED PARTICLES IN HELICAL TOROIDAL MAGNETIC FIELDS. Khapaev, M. M. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 40-6(May-June 1966). (In Russian).

Toroidal helical fields for fast particles were investigated using the nonlinear theory of motion considering the toroidal distortions and constructed on the basis of the method of averages. The parameters of strong-focusing systems and particle-channeling systems are described by means of formulas developed on the basis of helical fields. (tr-auth)

16900 PULSE HEATING IN A HIGH PRESSURE ARGON ARC. Mitin, R. V.; Knyazev, Yu. R.; Petrenko, V. I.; Borovik, E. S. pp 248-66 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

A study was made of a dense high-temperature argon plasma heated by a steady current with very high current pulses superimposed for a sufficiently long time to establish thermal and hydrodynamic equilibrium. The experimental system consists of the steady current source, a pulse current source (bank of capacitors) and a discharge chamber. The electrical characteristics of the system are described and the dynamic characteristics are given for several capacitor charges. The argon arc was studied spectroscopically and optically with the following results: (1) the electric field in the plasma column was found to have a constant value in the axial direction. Its value increased slightly with cur-

rent and pressure increase ($\frac{1}{3}$ and $\frac{1}{4}$ powers, respectively); (2) surface radiance increased linearly with the electric power delivered to 1 cm of the arc and at 3.5×10^6 W/cm reached a value corresponding to a black body of 12000°K; (3) the charged particle density reached 10^{19} in one cm^3 and the temperature in the central position of the arc discharge was found to be in the range of 30,000 to 70,000°K. (ATD)

16901 BEHAVIOR OF A CHARGED PARTICLE IN A CUSP FIELD. II. Shinano, Kunizo; Ito, Hiroshi (Osaka Univ.). J. Phys. Soc. Jap., 22: 605-10(Feb. 1967).

Behavior of a charged particle in a biconical cusp field is numerically investigated using a statistical approach. The present considerations are restricted to the case where a particle starts from one of point cusps, traverses the midplane and encounters the other point cusp. At the starting point of a particle, the values of the constant of motion and its magnetic moment are fixed, but the phase of gyration is chosen uniformly in the region $(0,2\pi)$. Statistical distribution for the magnetic moment of the particle in the latter adiabatic region is obtained. The probability that the magnetic moment of this particle becomes larger than the previous or a certain value is estimated. (auth)

Diagnostics of Plasma

16902 (INR-717/XVIII/PP) SPEKTRALN BADANIA PLAZMY W UKLADZIE Z DZIALEM PRETOWYM "DP". CZESC I. TEORIA POMIAROW SPEKTRALNYCH W DZIALACH PLAZMOWYCH. (Spectroscopic Plasma Research in a Device With the Rod Gun "DP". Part I. Theory of Spectroscopic Measurements in Plasma Guns). Suckewer, Szymon (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 54p. (In Polish). Dep.

A detailed theory is presented for spectroscopic measurements of the ion and electron temperatures and plasma density with regard to conditions in the rod plasma gun, DP. Problems of electron temperature measurements have been studied closely, for the density distributions of excited states of atoms and ions differ from a distribution described by Boltzmann's statistical formula. It is shown that for a certain range of electron temperatures of nonthermal plasma (the departure from thermal equilibrium on account of too small density of plasma) there are some excited levels for which density ratios are given by Boltzmann's formula. The electron temperatures can then be calculated from the chosen excited levels, as in the case of a thermal plasma. (auth)

16903 (INR-718/XVIII/PP) SPEKTRALNE BADANIA PLAZMY W UKLADZIE Z DZIALEM PRETOWYM "DP". CZESC II. POMIARY TEMPERATURY PLAZMY. (Spectroscopic Plasma Research in a Device With the Rod Gun "DP". Part II. Measurements of Plasma Temperature). Suckewer, Sz. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 74p. (In Polish). Dep.

Results are presented of measurements of electron and ion temperatures in the rod guns DP-I and DP-II. These measurements were made on the basis of a theory given earlier. The ion temperature measurements from observations along and perpendicularly to the gun axis provided facilities for elimination of correlative axial motions of the plasma. It was observed that T_i grows, together with an increase of an ion charge, but an increment of the initial pressure in a discharge chamber causes a decrease of the ion temperature T_i. The greatest value $T_i = 1.5 \times 10^6$ °K was observed for the initial pressure (of air) $p = 10^{-4}$ torr, but the electron temperatures have not exceeded $T_e = 5 \times 10^4$ °K. Ion and electron temperature distribution plots vs the distance from the gun axis are given. The great differences between the ion temperature T_i and the electron temperature T_e are also discussed. (auth)

16904 (INR-719/XVIII/PP) ZALEZNOSCI CZASOWE WYSWIECANIA LINII WIDMOWYCH A DYNAMIKA PROCESOW W DZIALE PRETOWYM "DP". (Time Behaviour of Spectral Lines and the Dynamics of Processes in the Rod Plasma Gun "DP"). Gryzinski, M.; Nowikowski, J.; Suckewer, S. (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 28p. (In Polish). Dep.

Time-dependent measurements of spectral line intensities performed on the rod plasma gun, DP, are given and discussed. Conclusions concerning the role of gases leaving the surfaces of the electrodes are drawn. Efficiency for removal of the gas from the gun was determined. Using the data for intensities of spectral lines, concentration of electrons and time behavior of electron temperature were calculated. Electron densities were found to be of the order of 10^{15} cm^{-3} and electron temperatures of the order of 6×10^4 °K. (auth)

16905 (INR-720/XVIII/PP) POMIARY SONDAMI MAGNETYCZNYMI W UKLADZIE Z PRETOWYM DZIALEM PLAZMOWYM "DP". (Magnetic Probe Measurements in a Device With the Rod Plasma Gun "DP"). Sadowski, Marek; Skladnik-Sadowska, Elzbieta (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 36p. (In Polish). Dep.

Magnetic probe measurements were made on a plasma generated by a new-type injector—the rod plasma gun DP. Average values of the axial component of a plasma magnetic field and propagation velocities of uncompensated charges outside an outer magnetic field or of plasma blobs in an outer field, as well as time correlations of probe signals with oscillations of the discharge current are given, on the basis of oscillograms from outer probes. A breaking-down process of the rod plasma gun as well as components of a local magnetic field and local components of a current-density vector in a plasma were studied with small inner probes. In the plasma generated by the rod gun there are very substantial azimuthal currents that circulate over large radii according to the space between the gun electrodes. (auth)

16906 ELECTRON-BEAM-PROBING STUDIES OF BEAM-PLASMA INTERACTIONS. Cannara, A. B.; Crawford, F. W. (Stanford Univ., Calif.). J. Appl. Phys., 38: 583-90(Feb. 1967).

Experimental observations of electron-beam–plasma amplification in a low-pressure, beam-produced, mercury-vapor discharge are described. A nonperturbing probing technique, employing a fine auxiliary electron beam, was used to measure rf growth, phase velocity, and axial and radial electric-field profiles in the interaction region. The comprehensive data obtained were compared with predictions based on cold- and warm-plasma theories of beam–plasma amplification. It is concluded that the experimental growth rates and electric-field profiles are approached more closely by warm-plasma theory, but that the measured phase velocities are somewhat slower than either theory suggests. The electric-field profiles are smoother than expected, probably owing to the beam boundary being less sharp in practice than is assumed in the theories. (auth)

16907 MICROWAVE INVESTIGATION OF PLASMAS PRODUCED IN A REACTOR. Bhattacharya, A. K.; Verdeyen, J. T.; Adler, F. T.; Goldstein, L. (Univ. of Illinois, Urbana). J. Appl. Phys., 38: 527-34(Feb. 1967).

The results of a microwave investigation of gaseous plasmas produced by the radiation field within the core of a water-cooled nuclear reactor are reported. It is shown that the plasmas thus formed are applicable in reactor instrumentation and are quite suitable for investigating basic plasma phenomena such as various collision cross sections and electron-loss processes. Radiometric electron-temperature measurements indicate that, at adequately high gas pressures (≥50 torr) in the light noble gases used, the electron gas temperature is at or near the host gas temperature and is independent of the reactor power. The dependence of the electron temperature on the gas pressure has been utilized to determine the electron-neutral collision frequency in neon at different electron energies and in helium at room temperature. Preliminary measurements give a value of 2×10^{-9} $cm^3 \cdot sec^{-1}$ for the recombination coefficient in helium at room temperature. (auth)

16908 LONGITUDINAL WAVES IN A HOT NONUNIFORM PLASMA. Lonngren, K. E. (Univ. of Iowa, Iowa City). IEEE (Inst. Elec. Electron. Eng.) Trans. Microwave Theory Tech., MTT-14: 494-5(Oct. 1966).

Measurements have been made of wave propagation whose characteristic velocities are on the order of the speed of sound for the electron gas, $(\gamma kT/m)^{\frac{1}{2}}$, where γ is a constant on the order of unity. Harmonic generation of these modes has been detected and they have been used to study drift velocities in the positive column of a mercury vapor discharge tube. The propagation of these temperature-dependent waves in a slightly inhomogeneous hot plasma was examined. The positive column of a mercury vapor discharge possesses this slight inhomogeneity in its long dimension. An expression was obtained for the longitudinal field which showed that the longitudinal wave propagates with a propagation constant that is temperature-dependent and decays (or grows) as a function of the inhomogeneity of the plasma. This decay (growth) is in addition to that predicted by Landau. In a typical mercury vapor discharge plasma, the e-folding distance was estimated to be $4/\pi$ m at a frequency of 2 Mc. From earlier measurements the e-folding distance was estimated to be 0.43 m for the case of a discharge current of 1 A. At very high frequencies, this effect would probably be negated by the Landau damping. Collisional damping was neglected in this calculation. Since this longitudinal wave has an amplitude term that is a function of the density and a phase term that is a function of the temperature and density, an

application of this wave as diagnostics with microwaves is proposed to determine the number density and temperature of a hot inhomogeneous plasma. (BBB)

16909 MICROWAVE EMISSION OF QUASI STATIONARY PLASMA. Gorokhov, N. A.; Dolgov-Savelev, G. G. At. Energ. (USSR), 21: 295(Oct. 1966). (In Russian).

Specially constructed devices were used in the investigation of microwave radiation of high-temperature plasma in Tokomak-type installations. The results showed that the plasma acts as an electromagnetic radiation source of millimetric length wave range. The radiation appeared sporadically and consisted of series of bursts with the intensity corresponding to the brightness of the pinch of the order of 10^{-3} W/strad. cm^2. A Fabry–Perot interferometer was used for recording the generated radiation spectrum. The maximum intensity was found near the electron plasma frequency. The radiation appeared only in discharges where plasma formation was macroscopically stable. Investigations of the strong (over 100 eV) x radiation appearing during fast particle bombardment of the chamber walls showed that the initial moments of the beginning and ending of the generation of microwave and x radiation are correlated. (R.V.J.)

Kinetics of Plasma

Refer also to abstract 16905.

16910 (INR-711/XVIII/PP) KONCEPCJA PRETOWEGO (MAGNETOELEKTRYCZNEGO) DZIĄLA PLAZMOWEGO "DP". (Concept of Rod/Magnetoelectric/Plasma Gun: "DP"). Gryzinski, Michal (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 34p. (In Polish). Dep.

The concept of a device intended for creation of a highly focused stream of hot plasma of densities and temperatures interesting from the point of view of controlled thermonuclear research is given. Solid electrodes of the coaxial plasma gun are replaced by grid electrodes (electrodes "transparent" for the particles) so that the radial motion of particles becomes unlimited, and the strong concentration of particles at the axis of the device can be achieved. Using the one-particle model, the basic relations for perfectly transparent and perfectly smooth electrodes are derived. The question of space charges is briefly discussed. It is also shown that the proper construction of "transparent" electrodes (rod plasma gun) and the properly chosen working conditions make it possible to avert decrease of focusing properties resulting from the rough structure of concrete electrodes. The numerical calculations for the particular construction have been done. (auth)

16911 (INR-712/VII/PP) RUCH CZASTEK NALADOWANYCH W PRETOWYM DZIALE PLAZMOWYM "DP". (On the Motion of a Charged Particle in a Rod Plasma Injector "DP"). Kulinski, S. (Institute of Nuclear Research, Warsaw (Poland)). Oct. 1966. 64p. (In Polish). Dep.

The electric and magnetic field distributions in a rod plasma injector, "DP," is found, and the motion of a charged particle in these fields is considered. The conditions are given for which the ions gain considerable transversal motion energies and there is also the possibility of focusing these ions in the vicinity of the axis. This injector and a coaxial plasma gun with transparent inner electrode are compared. The equations of motion are solved numerically, with the aid of computer GIER for the "DP" device. (auth)

16912 (INR-713/XVIII/PP) UKLAD EKSPERYMENTALNY Z PRETOWYM DZIALEM PLASMOWYM "DP". (An Experimental Device With the Rod Plasma Gun "DP"). Gryzinski, Michal; Nowikowski, Jerzy; Sadowski, Marek (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 28p. (In Polish). Dep.

Details are presented of an experimental device for research of a new-type injector, i.e., the rod plasma gun DP. The construction of the current pulse generator and the shielding arrangement are described. The constructive details of a vacuum system and of an expansion chamber with a gas feeder are also given. An air-core electromagnet that has been used for creation of an outer magnetic field, as well as a control system, are also described. Particular attention is devoted to the description of the plasma gun itself. (auth)

16913 (INR-714/XVIII/PP) POMIARY PRADOW I NAPIEC PRETOWEGO DZIALA PLAZMOWEGO "DP". (Current and Voltage Measurements on the Rod Plasma Gun "DP"). Nowikowski, J. (Institute of Nuclear Research, Warsaw (Poland) . May 1966. 26p. (In Polish). Dep.

The circuits for measurements of current and voltage of the rod plasma gun DP are described, and the results of measurements at the pressures in the range 5×10^{-5} to 10^{-1} torr are given. Parameters of the storage bank, equivalent resistance of the gun, and energies delivered to the plasma have been calculated. Times to breakdown of the gun have been also measured. (auth)

16914 (INR-715/XVIII/PP) ANALIZA PRACY PRETOWEGO DZIALA PLAZMOWEGO "DP" PRZY POMOCY ULTRASZYBKIEJ FOTOGRAFII. (Analysis of Operation of Rod Plasma Gun "DP" Using Methods of Rapid Photography). Gryzinski, Michal (Institute of Nuclear Research, Warsaw (Poland)). May 1966. 30p. (In Polish). Dep.

Results given of observations of luminosity of plasma in the rod plasma gun DP with a rapid-picture framing camera are given. The pictures confirm theoretical foresights achieved on the basis of the one-particle model. It has been found that plasma is accelerated in the magnetohydrodynamic process at pressures of the order of 10^{-1} mm of Hg and in the magnetoelectric process at pressures of 10^{-2} to 10^{-3} mm of Hg. Jets of plasma in the vicinity of the axis of the gun, characteristic for magnetoelectric acceleration, have been observed. Axial velocities of streams of plasma have been determined. The velocities varied from 10^6 cm/sec at a pressure of 10^{-1} mm of Hg to 5×10^6 cm/sec at 10^{-4} mm of Hg, so that respective energies of axial motions varied from a few eV to some hundred eV. Throughout all experiments air was used as the working gas. (auth)

16915 (NP–16583) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF GASES AND PLASMAS. No. 21. Brewer, L. (comp.) (California Univ., Berkeley). Dec. 31, 1966. 23p. NBS, Washington, D. C. Free.

A listing is given of 87 papers dealing with spectroscopy of interest in high-temperature chemistry. In addition, a listing is given of 111 papers on reactions between gases and condensed phases. (M.O.W.)

16916 CONTRIBUTION TO THE THEORY OF RADIATION TRANSFER IN PLASMA. Vasil'ev, A. P.; Kogan, V. I. Dokl. Akad. Nauk SSSR, 170: 1044-7(Oct. 11, 1966). (In Russian).

A discussion is presented on the difficulties involved in solving the radiation-transport equation, connected primarily with the fact that the kernel of the integral equation for the transport of resonant radiation does not decrease sufficiently rapidly with distance, making this equation irreducible to a differential form. Physically this makes the radiation-transport equations different from diffusion equations and impossible to solve by a diffusion approximation. It is shown that this is not always the case, and that the total frequency redistribution occurring during the re-radiation act does not by itself lead to the non-diffuse nature of the radiation-transport process. The analysis is carried out for ionization equilibrium between an impurity in a plasma of finite dimensions, using a simple model of a hydrogen-like atom whose electron can be either at a single discrete level or in a continuous spectrum. It is further postulated that in all types of radiation the transport is accompanied by complete redistribution of the frequencies during the re-radiation act. The causes of the slow decrease of the kernel of the integral equation are then analyzed and it is concluded that the slow variation of the kernel is not always an obstacle to a solution of the problem, since the ionization-equilibrium equation can be reduced to a balance equation for the number of excited atoms in the two-level model, and the balance equation can in turn be reduced to an asymptotic form that admits of solution in the diffusion approximation. (ATD)

16917 ELECTRON CAPTURE AND LOSS IN ELECTRON SWARM EXPERIMENTS. Ritchie, R. H.; Turner, J. E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Z. Phys., 200: 259-69(1967). (ORNL-P-2664).

The effect of capture and subsequent loss of electrons upon their time distribution in time-of-flight electron swarm experiments has been investigated. It is found that if the mean release time of captured electrons is much smaller than both the drift time and the time width of the electron swarm distribution, the effective diffusion coefficient D′ is given approximately by $D' = (\xi D + \xi^2 \beta w^2 / 2\gamma^2)$, where D is the electron diffusion coefficient in the absence of capture, w is the drift velocity, γ is the inverse release time, β is the inverse capture time and $\xi = \gamma/(\beta + \gamma)$. It is shown that measurements of w and D by the steady state Townsend method should be unaffected by temporary capture processes. (auth)

16918 EXACT PAIR CORRELATION FUNCTION FOR A TWO-DIMENSIONAL COULOMB GAS. May, R. M. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 24A: 279-80(Feb. 27, 1967).

The exact equilibrium two-particle correlation function for a two dimensional Coulomb gas is derived. This exact solution in-

volves only a Bessel function, and can readily be compared with various approximate solutions. (auth)

16919 MEASUREMENTS OF THE CURRENT DENSITY DISTRIBUTION IN THE EXHAUST OF AN MPD ARCJET. Powers, William E. (Avco Corp., Wilmington, Mass.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 545-50(Mar. 1967).

The plasma current patterns of an MPD arcjet were determined experimentally by detecting the current-induced magnetic field changes with Hall-effect sensors. Insulated water-cooled probes were traversed radially and axially to define the magnetic field gradients that reflect the current density components j_r, j_θ, and j_z. The nature of the discharge was explored for variations in mass flow, power from 25 to 75 kW, and applied magnetic field up to 1500 gauss, using hydrogen, ammonia, nitrogen, and argon propellant gases. The surveys reveal a discharge plume characterized by a centralized cathode current, with restricted radial current flow, conforming in essence to a magnetic nozzle channeling shaped by the applied field. The coaxial anode current sheath extends over a considerable volume. An axial extension of the current occurs with increase in the applied magnetic field. However, less than 15% of the total current was detected in the plume of ammonia and argon, with 20 to 40% for nitrogen and hydrogen. Electromagnetic interactions in the portion of the beam that was probed account for only a small fraction of the MPD arcjet thrust. Current leakage within the nozzle may manifest azimuthal energy addition, and special swirl probes were employed to search for this. Measurements taken with magnetic probes to evaluate azimuthal Hall-current flow did not display measurable levels. (auth)

16920 MEASUREMENT OF VELOCITIES AND ACCELERATION MECHANISM FOR COAXIAL HALL ACCELERATORS. Burlock, J.; Brockman, P.; Hess, R. V.; Brooks, D. R. (Langley Research Center, Hampton, Va.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 558-61(Mar. 1967).

Kinetic particle energies in excess of energy gained by singly charged particles from applied voltage have been reported for coaxial Hall accelerators by NASA Langley, Avco Wilmington, and Electro-Optical Systems, using a variety of propellants. Results were based on measurements of thrust and mass flow except for some preliminary velocity measurements by NASA and Avco. To determine if high exhaust energies are genuine or caused by entrainment of ambient (vacuum tank) gas or of electrode material, more direct measurements of exhaust velocities were made. Results of axial and radial surveys of the velocity of distribution using single and double Langmuir probes are reported. At the low tank pressures used, the mean free path is larger than the probe dimensions. These results show evidence of local kinetic energies that equal and possibly exceed those obtainable from the applied voltage. Some $v \times B$ probe velocity measurements are discussed. (auth)

16921 THERMAL EXCITATION FUNCTIONS AND NORMAL TEMPERATURES OF ATOM AND ION LINES IN TWO-COMPONENT PLASMA. Diermeier, R.; Krempl, H. (Technische Hochschule, Munich). Z. Phys., 200: 239-48(1967). (In German).

Within the temperature region 3,000 to 50,000°K and the pressure region 0.1 to 5 atm thermal excitation functions of several important I, II and III spectral lines of the metals Na, Al, Fe, Zn, and C have been calculated by means of a computer. Their optimum temperatures have been tabulated. If these elements are mixed with a second component with an essentially higher ionization energy, such as argon, then the optimum temperatures of atom lines are shifted to lower values. The lowering of the total pressure in the plasma causes the same effect. Moreover a second optimum temperature occurs at approximately 11,000°K in plasmas of high dilution. This second maximum depends on the starting ionization of argon which decelerates the decrease of the atoms of the metal component. The relation of the optimum temperature with ionization energy, pressure and concentration can be described by linear equations, according to a previously published approximation formula. The spectral lines of ions are less influenced by these parameters, especially by the second component. (auth)

16922 INVESTIGATIONS ON PLASMA THRUSTERS WITH THERMAL AND SELF-MAGNETIC ACCELERATION. Huegel, H.; Kruelle, G.; Peters, T. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart). AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 551-8(Mar. 1967).

Acceleration of propellant in arcjet devices by thermal and self-magnetic forces is investigated theoretically and experimentally. An axially symmetric direct current arc is operated within a rapidly expanding supersonic plasma flow, which is achieved in a free-expansion plume as well as in various nozzle configurations with wide opening angles. According to low mass flow rates, pressures of about 20 to 100 mm Hg are built up in the vicinity of the tungsten cathode. This leads to cathode operation that, showing a large spotless arc attachment, is different from that known at high pressures. The anode is situated downstream in the low-pressure region, typical values of ambient pressure being 0.1 to 3 mm Hg. High-speed motion pictures and oscillographic measurements seem to indicate that the anode attachment is of a diffuse-type. The experiments cover a current range from 200 to 2000 A with argon and 200 to 1000 A with helium and hydrogen as working gases. In a nozzle configuration, the Mach number of the exhaust stream is observed to be increased by self-magnetic forces. Thermal acceleration, however, still contributes substantially to thrust production in the devices. (auth)

16923 USE OF IONIZATION LEVEL AS AN INDEPENDENT VARIABLE FOR PLOTTING PLASMA TRANSPORT PROPERTIES. Haldeman, Charles W.; Covert, Eugene E. (Massachusetts Inst. of Tech., Cambridge). Contract AF 33(615)-2790. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 5: 600-1(Mar. 1967).

The use of ionization level as a parameter may prove useful in the design of MHD plasma devices, since they are frequently limited in operation by viscous effects. Since evaluation of the viscosity under the conditions is tedious, a simplified approximation based upon previous arguments from the kinetic theory of gases by Hirschfelder et al., is shown for the evaluation of viscosity of ionized gases. Consideration is given the ratio of actual to Sutherland viscosity as a function of the ionization fraction, and results are plotted. Results are also plotted from computations of electric conductivity, with fully ionized and Lorentz gas resistivities added. (J.H.M.)

16924 EXCITATION AND DAMPING OF DRIFT WAVES. Wong, A. Y.; Rowberg, R. (Univ. of California, Los Angeles). Phys. Rev. Lett., 18: 390-2(Mar. 13, 1967).

In an inhomogeneous plasma immersed in a magnetic field, there are waves associated with the density and temperature gradients. Results are presented from excitation and damping of such drift waves in the stable regime in a highly ionized plasma. (M.O.W.)

16925 MEASUREMENT OF IMPEDANCE AND POWER ABSORPTION OF A CYLINDRICAL PLASMA COLUMN AT 27 MHz. Paulin, Alojz (Eidgenoessische Technische Hochschule, Zurich). Z. Angew. Phys., 22: 308-12(Mar. 1967). (In German).

The rf power absorption, conductance, and susceptance at 27.1 MHz were measured, using capacitive and inductive coupling on an argon plasma column and varying in turn, the magnetic field, the vacuum, and the ion density. The absorption of power is smaller and the stability is better in the capacitive case; however, the conductance is larger in the inductive case. By using an external magnetic field perpendicular to the rf electrical field, it is possible to raise the conductance in the capacitive case and, therefore, improve performance for practical purposes. (auth)

16926 ELECTRIC CONDUCTIVITY AND HEAT CONDUCTIVITY OF ARGON AT HIGH TEMPERATURE. Bues, Irmela (Univ., Kiel); Richter, Johannes; Patt, Hans-Josef. Z. Angew. Phys., 22: 345-50(Mar. 1967). (In German).

By measuring the electric field strength, the radiated power, and the temperature of a wall-stabilized argon arc, the electric and thermal conductivities of argon at atmospheric pressure and temperatures between 9000 and 15000°K were determined. Near 15,000°K, the electric conductivity agrees with the values calculated by Spitzer's formula. (auth)

16927 ACCELERATION OF PLASMOIDS IN WAVE-GUIDES BY A SUPERHIGH-FREQUENCY WAVE. Domrin, V. I.; Ramazashvili, R. R. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 312-17(Feb. 1967). (In Russian).

The acceleration of an opaque plasmoid by an electromagnetic wave in a waveguide is considered. The acceleration process is investigated in detail in the case when the group velocity of the wave in the waveguide is much less than the velocity of light in vacuum. (auth)

16928 SINGULAR SOLUTIONS OF CERTAIN INTEGRAL EQUATIONS. Case, K. M. (Inst. for Defense Analyses, Arlington, Va.). J. Math. Phys. (N. Y.), 7: 2125-35(Dec. 1966).

A class of integral equations arising in some idealized plasma problems is discussed. While these do not have solutions in the space of square-integrable functions, they do have such in an appropriate space of generalized functions. Explicit solutions are given in some special cases. It is then shown how these solutions can be used to approximate those for more general problems. (auth)

16929 NEW DERIVATION OF THE KINETIC EQUATION FOR AN INHOMOGENEOUS PLASMA. Kuszell, A. (Inst. of Nuclear Research, Warsaw). J. Math. Phys. (N. Y.), 7: 2211-16(Dec. 1966).

The kinetic equation for nonuniform plasma is derived from the Liouville equation by the Prigogine–Balescu diagram technique. The obtained equation is equivalent to the equation derived earlier by Balescu and this author, but has a little simpler form. The equation has a non-Markoffian form and is valid in both stable and unstable cases and for long and short times. Its explicit form is obtained by using the Resibois' summation procedure. The limiting form of the equation for long times in the stable case is derived. (auth)

16930 FARADAY ROTATION OF A MICROWAVE THROUGH A LOSSY PLASMA. Takeda, Susumu; Minami, Kazuo; Matsuoka, Ryosuke (Univ. of Nagoya, Japan). Jap. J. Appl. Phys., 6: 384-92(Mar. 1967).

The elliptically polarized Faraday effect appears when microwaves are transmitted through lossy plasmas with magnetic fields. The detector signal of an electric field component of a wave through plasmas oscillates with the monotonous decrease of the plasma electron density, when the cyclotron frequency is higher than the applied frequency. The electron density and the collision frequency can be easily determined from the maxima and the minima of the detector signal. From the detected microwave signal through a neon afterglow plasma in a waveguide at pressures of 1.9 and 5.0 torr, the electron density, which decays from 10^{12} to 10^{9} cm^{-3} with time, is determined for magnetic fields varying from 3400 to 6000 gauss. These decays show reasonable agreement with the recombination coefficient during the latter part of the period, when the electron energy relaxes to thermal equilibrium with the gas temperature and the recombination loss predominates over the diffusion loss. The collision frequencies of electrons with ions and neutral atoms are determined and plotted against the electron density. These values are somewhat higher than the theoretical ones. (auth)

16931 STEADY-STATE PROPERTIES OF A COLLISION-FREE, CYLINDRICAL PLASMA INJECTED IN LONGITUDINAL MAGNETIC FIELD. Okuda, Takayoshi (CEN, Saclay, Gif-sur-Yvette, France). Jap. J. Appl. Phys., 6: 393-402(Mar. 1967).

Discussions are given to clarify the steady state properties of a collision-free, cylindrical plasma of zero temperature in the presence of longitudinal magnetic field, with the aim of studying injected or synthesized plasma. A new picture is proposed, suggesting that the space charge field arising from inequality of charge density between the electron and ion may control the radial velocities of the electron and ion to satisfy a condition imposed on the total radial current density. The most realistic condition is such that the total current density is equal to zero. The potential and kinetic energies or velocities are analyzed as a function of radial coordinate for homogeneous plasmas. The collection of charged particles on a cylindrical electrode, parallel to the direction of the magnetic field, is discussed. The steady transient time and the focusing or spreading are also discussed. (auth)

16932 FORCES ACTING ON CHARGED CURRENT-CARRYING RING MOVING WITHIN A CONDUCTING CYLINDRICAL PIPE. Il'in, V. D. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 121-3(May-June 1966). (In Russian).

A ring-shaped current in a cylindrical tube was studied in order to determine the possibility of radiative acceleration of plasma rings with currents in waveguides. (R.V.J.)

16933 DISPERSION OF PULSED ELECTROMAGNETIC WAVES IN A PLASMA. Schmitt, H. J. (Sperry Rand Research Center, Sudbury, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Microwave Theory Tech., MTT-13: 472-3(July 1965).

Calculations were made of the distortion of a pulsed electromagnetic wave (angular frequency ω_s) caused by a reflection from a semi-infinite uniform and isotropic plasma (angular plasma frequency ω_p), and the distortion of a pulsed wave transmitted through a plasma by convolution of the response for a short unidirectional pulse. (M.O.W.)

16934 ELECTROMAGNETIC FIELDS IN PLASMA GUIDES. Ohokubo, M. (Gunma Univ., Japan). Denki Gakkai Zasshi, 84: 1-7(1964).

Johnson earlier derived the dispersion relation for a waveguide completely filled with plasma, but no analysis for the case of a partially filled waveguide has been available. The dispersion relation for the general case is derived here, and cutoff frequencies of various modes are calculated numerically. In addition, several new results concerning characteristic impedances of plasmaguides are presented. (M.O.W.)

16935 COUPLING OF TRANSVERSE AND LONGITUDINAL WAVES BELOW THE SECOND ELECTRON CYCLOTRON HARMONIC. Kuehl, H. H. (Univ. of Southern California, Los Angeles). Phys. Rev., 154: 124-9(Feb. 5, 1967).

A theory is developed for the behavior of the field due to a transverse wave, with propagation direction and electric field perpendicular to the static magnetic field, incident on a nonuniform plasma half space. The transmission and reflection coefficients are computed for frequencies below the second cyclotron harmonic. It is shown that the coupling to the plasma wave is efficient only if the width of the region in which the density increases from zero to its maximum value is of the order of or less than a free-space wavelength. (auth)

16936 DEBYE SHIELDING AND VIRTUAL PLASMA OSCILLATIONS. Schulz, Michael (Massachusetts Inst. of Tech., Cambridge). Amer. J. Phys., 35: 117-18(Feb. 1967).

It is noted that Debye shielding between charges in a one-fluid plasma, and under certain conditions in a two-fluid plasma, can be represented formally by coupling the charges to a field of isothermal plasma oscillations. The field-theoretic calculation required in such a model would be equivalent mathematically to the coupling of point sources to a field having quanta of nonzero mass, and so the resulting potentials would have the same form, as is known to be the case in the usual thermodynamic model for Debye shielding. (auth)

16937 ENHANCED ENERGY LOSS BY A BEAM IN A PLASMA. Anno, Osamu (Tokyo Univ.). J. Phys. Soc. Jap., 22: 634-7 (Feb. 1967).

A beam injected in a plasma loses its energy owing to a resonant interaction, when the system approaches an unstable state. The interaction is treated in the framework of the wave theory, because the close binary collisions are not affected by the instability. The rate of energy loss is much larger than the value obtained by use of the test particle method. (auth)

16938 VZAIMODEISTVIE PUCHKOV ZARYAZHENNYKH CHASTITS S PLAZMOI. (Interactions of Beams of Charged Particles with a Plasma). Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. 274p.

Separate abstracts were prepared for 15 of the 28 included papers. The remaining 13 papers appeared previously in NSA 19: 8539, 12701, 17084, 21575, 32823, 33494, 33495, 37406, 41921, 47788, and 20: 6474, 20079, and 20082. (M.O.W.)

For abstracts of individual papers see: 16900, 16939–16951, and 17246.

16939 INVESTIGATION OF PARTICLE ENERGY AND CONDITIONS OF EXCITATION OF LOW FREQUENCY OSCILLATIONS IN A PLASMA FORMED BY THE GROWTH OF INSTABILITIES IN A BEAM-PLASMA SYSTEM. Kornilov, E. A.; Kovpik, O. F.; Fainberg, Ya. B.; Khrachenko, I. F. pp 24-35 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The conditions necessary for the excitation of ion currents in experiments where electron beams traverse the plasma are reported. The experiment is described and a diagram of it is given. An electron beam of 2 to 5-keV electrons (10 to 80 mA) is incident on the plasma in the magnetic field (0 to 2 kg) parallel to the beam. Movable analyzers were used thus permitting the interaction length of beam and plasma to be changed. Analysis of the discharge showed that ion current density across the magnetic field lines is smaller than that along the field lines. These currents could be generated only when the ambient pressure was between 4×10^{-4} and 10^{-2} mm Hg. The current maximum also appears at a pressure corresponding to maximum plasma oscillations. It is also shown that the electron–ion currents emerging from the plasma are equal to the current entering the plasma. The observation of outflowing currents has shown that for sufficiently long plasma-beam interaction length, the current from the end of the plasma consisted solely of ions. The investigation of the frequency distribution of the excited oscillations shows that the ion current arises in situations favoring the production of instabilities. The most favorable conditions for generating beams of ions with energies up to 1 keV are given. The study of excitation frequency change with electron temperature and type of gas used shows that the low frequency oscillations generated in the experiment were near the ion-acoustic frequencies. (ATD)

16940 INTERACTION OF ION BEAMS WITH A PLASMA. Gabovich, M. D.; Kirichenko, G. S.; Koidak, V. S. pp 44-51 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The experimental parameters were chosen to satisfy the instability criteria derived by Vedenov, et al., using a cesium ion beam

with an energy of several eV. A plasma of 10^{10} cm^{-3} particle density was produced in inert gas discharges. Beam density was of the same order of magnitude. The amplitude and frequency of oscillations excited by ion beams was studied as a function of the electron temperature, gas density and ion mass. It is shown that the peak amplitude of the frequency spectrum can be explained by the theoretical ion beam energy at which stable operation occurs. As magnetic field was increased (in a direction parallel to the beam), there was a great increase in noise which made the diagnostic measurement more difficult. However, it was possible to show that the excited oscillations have the same character as in the case where there is no magnetic field. In particular, the critical beam energy above which stable operation occurs was demonstrated through the use of a feedback scheme which generated a standing wave. The experimental results show that ion beams can be used for the plasma diagnostics since the critical energy depends strongly on the electron temperature of the plasma. (ATD)

16941 PULSATING DISTRIBUTIONS OF TURBULENT SOUND WAVES IN PLASMA. Akhiezer, I. A. pp 59-62 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The distribution of turbulent sound waves in a plasma with cold ions and hot electrons moving with a velocity greater than the speed of sound is considered. The equations of B. B. Kadomtsev, et al., are generalized by adding a time dependent term. These equations are analyzed under the assumption that short waves are the only important ones; derivative terms which do not depend on the correlating function are thus neglected. Appropriate substitution in the resulting equation reduces the number of variables and attention is directed to the study of similar solutions and their asymptotic forms are derived. It is shown that the "pulsating" distributions of fluctuations have periods which can be expressed in terms of random acoustic wave amplitudes. (ATD)

16942 EXCITATION AND PROPAGATION OF ELECTROMAGNETIC WAVES IN A TWO-LEVEL SYSTEM. Krasovitskii, V. B.; Kurilko, V. I. pp 62-8 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The interaction of a compensated uniform beam of charged particles with nonlinear medium is considered. The property of the medium is described by a semiclassical theory where the polarization vector is determined in terms of quantum mechanics and the electric and magnetic fields follow the classic description. It is assumed that the medium has two energy states and that dissipation effects are neglected. The system is described by Maxwell equations, and by equations describing the active medium. Analysis of these equations indicates that in the case of large amplitude waves, periodic pumping of the energy of longitudinal oscillations into the internal energy of the medium occurs. This leads to an inverted energy state population, the duration of which is computed. In this case, the period of oscillations increases logarithmically with decreasing initial amplitude of the oscillations. Development of small transverse oscillations also is considered; here it is shown that the influence of the medium on transverse propagation weakens as the wave amplitude increases. As the oscillations become very intense, the level populations are modulated with double the frequency of transverse oscillations. (ATD)

16943 NONLINEAR THEORY OF THE INTERACTION OF A RELATIVISTIC BEAM AND A PLASMA. Fainberg, Ya. B.; Shapiro, V. D. pp 92-103 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The dynamics of the development of instability appearing during the interaction of a relativistic uniform beam of electrons with a plasma is investigated from the initial phase through the saturating phase and the formation of a stationary spectrum of oscillations. It is assumed that the plasma is in strong magnetic field parallel to the beam direction and that the beam density is much smaller than the plasma density. The excited waves are considered to be one-dimensional and moving parallel to the beam. The kinetic equation and field equations are analyzed for several degrees of nonlinearity. It is shown that beam acceleration occurs at the expense of increasing the thermal spread of the beam and the kinetic and potential energy of the induced oscillations. For larger values of beam velocities, the instability leads to a second quasilinear phase. At lower values, the beam remains uniform. The analysis also brings out the existence of a strong oscillating additive term in such beam characteristics as density and momentum. (ATD)

16944 QUASILINEAR THEORY OF THE INTERACTION OF BOUNDED BEAMS AND A PLASMA IN A STRONG MAGNETIC FIELD. Gorbatenko, M. F.; Shapiro, V. D. pp 103-11 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

Utilizing the results of V. D. Shapiro and V. I. Shevchenko, the development of instabilities during the interaction of a low-density cylindrical beam with a plasma is investigated by including the nonlinear approximations. The boundary condition on the plasma is taken to be a conducting wall and the plasma is contained by a strong magnetic field. First, the interaction of plasma with a uniform beam with small thermal spread is considered. It is shown that in this case, quasilinear theory can be applied when the amplitude of excitation becomes great. Next, a beam with great thermal energy component is analyzed. The dispersion relation for this case yields the amount of change of thermal energy of the beam. This, in turn, shows that most of the directed energy of the beam is converted into plasma thermal energy. In the case considered here, the deceleration of the beam and excitation of oscillations are derived and shown to be much longer than in the unbounded case if certain parameters are satisfied. The instability development is traced through the saturation phase and the establishment of a stationary state. (ATD)

16945 INTERACTION OF AN ELECTRON BEAM WITH AN OPTICALLY ACTIVE MEDIUM. Tsytovich, V. N.; Shapiro, V. D. pp 111-15 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The generation of oscillations in the visible and uv ranges is considered theoretically in the interacting system of a beam and an optically active plasma. The electron beam is of smaller density than the plasma and has a large thermal component. The plasma frequency is much smaller than that of the most rapidly growing harmonic, which is about equal to the characteristic frequency of the plasma. The spectrum of oscillations excited in the plasma is obtained from the quasilinear theory. At resonance, nearly all the energy of the beam goes into the kinetic energy of oscillators (i.e., atoms or ions of the plasma) exceeding the collisional transfer of energy to a large degree. A numerical example is given to show that very strong generation of light by this method is possible. It is shown that a beam with a density of 10^{14} cm^{-3} and a particle velocity of 3×10^9 cm/sec injected into a plasma with a density of 10^{19} cm^{-3} will generate 100 kW/cm^2 of power at 10^{16} sec^{-1} angular frequency (i.e., in the ultraviolet). (ATD)

16946 NONLINEAR STABILIZATION OF PLASMA BEAM INSTABILITIES. Tsytovich, V. N.; Shapiro, V. D. pp 115-30 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The study of plasma and interacting beam parameters shows that the stabilization of beams by nonlinear means is possible. The mechanism investigated in this connection is the pumping of excited oscillations into a nonresonant spectral region. It is assumed that the characteristic time of pumping is shorter than the instability development time, thus keeping the energy of the waves low. The spectral density time behavior is obtained by deriving the cross section for dispersion of Langmuir waves on the plasma particles. This is done both by use of the theory of growing amplitude excitations as well as by the quantum-mechanical approach (plasmons). The effects of nonlinearities are obtained from the dynamics of beam instabilities. It is shown that the beam can be accelerated by the excitation of internal electric fields. The analysis carried out in this work shows qualitatively that stabilization is possible in the absence of intense external noise. (ATD)

16947 MOVEMENT OF STREAMS OF CHARGED PARTICLES THROUGH A PLASMA AT AN ARBITRARY ANGLE RELATIVE TO THE INTERNAL MAGNETIC FIELD. Kitsenko, A. B.; Gapontsev, B. A. pp 131-6 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The excitation of high-frequency electron oscillations by a relativistic beam of charged particles moving in an arbitrary direction relative to the internal magnetic field is studied. The main interaction effect is assumed to take place where the wave frequency exceeds the cyclotron frequency of the beam and the wavelength is small compared with the cyclotron radius. The analysis of the tensor giving the dielectric properties of such interacting system gives the rate of growth of ordinary and extraor-

dinary waves. The simplifying assumption which considers only waves with phase velocity much smaller than that of light yields a simple expression for the growth coefficients. In addition, so-called "whistler waves" are considered as a special case, where it is shown that small phase velocity waves are most effectively generated when the angle between the wave vector and magnetic field direction approaches 90°. The case of nonrelativistic streams and their rate of growth obtained for the "whistler" mode case is also discussed. (ATD)

16948 EXCITATION OF LONGITUDINAL OSCILLATIONS IN A MAGNETOACTIVE PLASMA. Angeleiko, V. V.; Kitsenko, A. B. pp 136-43 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The excitation of longitudinal oscillations is investigated in a plasma consisting of two types of ions through which a stream of particles is moving under an arbitrary angle to the direction of the internal magnetic field. The dispersion relation for the plasma is analyzed and the relationship between its four roots is studied. In the presence of the stream, a new dispersion relation is written consisting of that for the plasma and the added term for the beam and for the interaction effects. This relationship is studied for the case of a cold stream under the conditions of Cherenkov resonance and for the case of a cold stream under conditions of anomalous Doppler effect. In addition, "hot" beam interaction with the plasma is briefly discussed. The instability criteria and growth rates for the various waves is given under specified relationships between the frequencies characterizing the plasma and beam systems. (ATD)

16949 LONGITUDINAL OSCILLATIONS IN MULTIVELOCITY PLASMA BEAM. Repalov, N. S.; Khizhnyak, N. A. pp 186-95 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

One-dimensional oscillations in a compensated plasma beam with an arbitrary distribution function are studied. The equations of motion and fields are written for a collisionless plasma with a set of electrons traversing modulating grids. The ions are treated as a background charge compensating for the space charge. It is shown that the system can be described more simply by use of the Euler equation when the electron velocity spread is small. The equations are solved by an indirect method which is an extension of Bogolyubov's method, using Lagrange variables. This approach, described in considerable detail, leads to an expression for corrections to the initial current and density harmonics. The latter turns out to be coherence factors. This approach is applied to an example of Maxwellian distribution, where the coherence factors in the velocity space have the same sense and structure as coherence factors in the configuration space. Current and density harmonics are also derived as is the decay length of an n-th density harmonic. The method described is shown to be valid for those situations where the Debye radius is much smaller than the wavelength, since otherwise the nonlinear effect leads to nonoscillatory solutions. (ATD)

16950 RESONANCE PROPAGATION OF AN ELECTRON BEAM IN A MEDIUM WITH A LAYERED DIELECTRIC. Repalov, N. S.; Khizhnyak, N. A. pp 195-203 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

The demodulating mechanism of the space charge on the beam moving through a medium with a layered structure is investigated. The problem is treated in the hydrodynamic approximation. It is further assumed that the dielectric is transparent with respect to the beam particles and produces no dispersion. The dielectric boundaries are normal to the beam. The static fluctuations of beam electrons are compensated by an ion background moving with constant velocity. The motion is described in Lagrangian coordinates. The nonlinear nature of the equation permits only the consideration of the case of an infinitestimal modulation amplitude. Bogolyubov's method is employed to clarify the effect of nonlinearities in the case of the medium with one change in the dielectric constant (two-layer dielectric). It is found that resonance effects under some conditions lead to an unstable increase in the modulating amplitude. The restriction of the problem to the region near the instability simplifies the equation under consideration. This solution reduces to that for beam bunching in klystrons where it is assumed that both dielectric layers have the same dielectric constant. (ATD)

16951 KINETIC THEORY OF A PLASMA WAVEGUIDE IN A STRONG MAGNETIC FIELD. Kondratenko, A. N. pp 235-40 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

A study was made of the propagation of axially symmetric electromagnetic waves in a cylindrical plasma waveguide which is placed in a sufficiently strong magnetic field (parallel to the waveguide) so that the transverse motion of ions and electrons can be neglected. The propagation is described by the dispersion equation for linear perturbations, Maxwell distribution of undisturbed electrons and singly-ionized atoms, and small phase velocity. The equation of dispersion is solved subject to the boundary conditions which are given by the appropriate continuity of field components. First, cold plasmas are considered. This case has two special conditions which make it possible to write the dispersion relations in analytic form. The simplest relation is where the propagating wave is near the electron plasma frequency. These results approach hydrodynamic solutions when the waveguide diameter becomes small or the thermal velocity vanishes. The damping coefficient is also found for these cases. Further, the propagation in an anisothermic plasma (ion-acoustic waves) is considered and the dispersion relations and damping coefficients are derived. The phase velocity decreases as the waveguide radius decreases, thus effectively decreasing the damping coefficients. (ATD)

Production of Plasma

16952 LASER-PRODUCED PLASMAS FROM SOLID HYDROGEN TARGETS. Saunders, P. A. H.; Avivi, P.; Millar, W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Lett., 24A: 290-1(Feb. 27, 1967).

A 500-MW ruby laser is focused onto a solid hydrogen filament. Ion collectors, microwaves, infrared detectors and photography are used to study the expanding plasma which contains $\sim 3 \times 10^{17}$ particles with several-hundred-eV average energy. (auth)

Stability of Plasma

16953 FLUTE INSTABILITY OF A PLASMA IN TOROIDAL GEOMETRY. Kadomtsev, B. B.; Pogutse, O. P. Dokl. Akad. Nauk SSSR, 170: 811-14(Oct. 1, 1966). (In Russian).

Flute instability of an ideally conducting plasma in toroidal discharge with strong longitudinal magnetic field, such as in the Tokamak system, is considered. The stability is defined by means of Suydam's condition. It is shown that this condition is not applicable to Tokamak systems in strong magnetic fields, since the flute instability arises in final analysis as a result of the bending of the force lines. A different stability criterion is derived from the balance equation, which is linearized under certain simplifying assumptions. It is assumed that the flute instability arises under perturbations which are strongly stretched along the force lines. The maximum radius of the torus under which the straight-line approximation is still valid is estimated. The final criterion obtained for the stabilization of the flute instability is $\beta_\varphi = 8\pi p/H_\varphi^2 < 1$, where p is the plasma pressure and H_φ the azimuthal magnetic field, under the assumption that p does not vary too smoothly with the small radius of the torus. (ATD)

16954 ELECTRON HEATING EFFECTS AND UNIVERSAL INSTABILITY IN CESIUM PLASMA. Sato, N.; Yamashita, Y.; Koganei, M.; Takahashi, N.; Ikezi, H. (Nagoya Univ., Japan). Phys. Lett., 24A: 293-4(Feb. 27, 1967).

The frequency of the electron drift waves is observed to increase with electron temperature and the experimental values of the frequency are quantitatively compared with the theoretical values. (auth)

16955 OBSERVATIONS OF A "HOSE" INSTABILITY OF AN ELECTRON BEAM IN A PLASMA. Abraham, E. E.; Crawford, F. W.; Mills, D. M. (Stanford Univ., Calif.). J. Appl. Phys., 38: 911-12(Feb. 1967).

Convective instabilities due to interaction of an electron beam with plasma have been studied for applications to plasma heating and microwave amplification. When correlation of theory and experiment has been attempted by predicting and measuring the growth rate, the axisymmetric mode has invariably been involved. The first azimuthally varying mode, for which growth of a hose-life instability is predicted, is considered. What is believed to be the first refined and unequivocal demonstration of the effect is presented. (W.D.M.)

16956 THE RELATIVISTIC GARDENHOSE INSTABILITY. II. Lerche, I. (Univ. of Chicago). Astrophys. J., 147: 681-8 (Feb. 1967).

For an anisotropic, spatially uniform, ultrarelativistic plasma, composed of protons and anti-protons (or electrons and positrons),

imbedded in an infinite, homogeneous magnetic field, the assumptions that are usually made in discussing the gardenhose instability in the long-wavelength, low-frequency regime are investigated. It is shown that for a particular non-Maxwellian distribution function the usual criterion for instability does not result. Instead of obtaining $4\pi (P_{||} - P_{\perp}) > H_0^2$, $P_{\perp} > P_{||}$ for instability is obtained. Thus for non-Maxwellian plasmas it is felt that some care should be exercised in dealing with the gardenhose mode. (auth)

16957 NONLINEAR EFFECTS OF HELICAL INSTABILITY IN SHORT MAGNETIZED POSITIVE COLUMNS. Yatsui, Kiyoshi; Inuishi, Yoshio (Osaka Univ.). J. Phys. Soc. Jap., 22: 626-34 (Feb. 1967).

The helical instability and oscillations in short positive columns immersed in longitudinal magnetic field are experimentally investigated. It was found that several higher order modes of helical instabilities begin to grow in turn with azimuthal mode number m coexisting with helical m = 1 mode as the magnetic field increases above a critical field B_c for the m = 1 mode. Helical m = 1 mode accompanies higher harmonics due to the nonlinearities above B_c. The nonlinear effects are enhanced with increasing magnetic field and carrier density. Oscillation frequency of the helix first increases with increasing magnetic field and finally decreases passing through a maximum in accordance with a nonlinear theory of Holter and Johnson. In a sufficiently short positive column, the plasma is always stable for all modes of instabilities independent of the magnetic field being in agreement with a short column theory of Timofeev. (auth)

Shielding

Refer also to abstracts 17199 and 17259.

16958 (ORNL-tr-1510) A DERIVATION OF BUILDUP FACTORS FOR ORDINARY CONCRETES FROM THE ATTENUATION COEFFICIENTS (GAMMA-RADIATION): FRANZISKA. Sasse, S.; Wueneke, C. D. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1002. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Starting with the series representation of buildup factors according to Seetzen, an approximation is made which is valid for concretes and similar materials for the energy range from 2 to 8 MeV. A computer program, FRANZISKA, was formulated which furnishes the coefficients of the model function and at the same time, shows the mean errors of the model functions. If the buildup factors are calculated with the use of these coefficients, a maximum mean error of 3% is obtained. (M.H.R.)

16959 SPATIAL DISTRIBUTION OF GAMMA-RAYS FROM A CYLINDRICAL ^{60}Co SOURCE. Kanemori, Yoshihiko (Mitsui Shipbuilding and Engineering Co., Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 32-6(Jan. 1967).

The spatial distribution of γ-dose rates from three sizes of cylindrical ^{60}Co sources were experimentally obtained. A cylindrical source of long, slender form was found to produce dose rates in the radial direction higher than from a point source with the same total source activity. The spatial distribution of γ-dose rates thus measured agreed fairly well with calculated values estimated for cylindrical surface sources emitting γ rays with a cosine angular distribution around the direction normal to the surface of the cylinder. (auth)

16960 GAMMA-RAYS AND NEUTRONS STREAMING ABOUT A CYLINDRICAL DUCT BY THE RAY ANALYSIS METHOD. Kitazume, Mitsuyuki (Hitachi Ltd., Tokyo); Tsuruo, Akira; Shindo, Mitsuo. J. Nucl. Sci. Technol. (Tokyo), 4: 11-20(Jan. 1967).

Studies were made on the fluxes and doses produced by an infinite plane source at the further side of duct exit surface of a shield barrier. The plane of infinite source is divided into four regions, and the contribution of each region is calculated separately by the ray analysis method. The total dose at the observation point and the contribution to it from each region of the plane source are calculated, using as parameters such factors as position of the observation point, duct radius, duct length, energy of radiation and shield material. The radius of influence created around the duct by its presence in respect of dose at the observation point, and the radius of contribution of the plane source in respect of flux at the duct centerline have been determined. The characteristics of the integrand that are significant for numerical integration are pointed out. The curves representing the results obtained should provide useful data for practical design work involving duct streaming problems. The method of calculation presented should not only be applicable to γ rays but also to fast neutrons. (auth)

Solid-State Physics

Refer also to abstracts 17021, 17262, 17266, 17267, and 17318.

16961 (JAERI-1113, pp 36-50) RECENT DEVELOPMENT IN THE THEORY OF LATTICE DYNAMICS. Toya, T. (In Japanese and English).

A review is given of the theoretical advances in the subject of lattice vibrations. A general approach to the properties of phonon dispersion is presented in terms of the shell model in ionic crystals and phonon–electron–phonon interactions in metallic crystals. The results of inelastic neutron-scattering experiments for the phonon dispersion relations are reviewed. Brief comments on the future problems of lattice vibrations are also given. (auth)

16962 (JAERI-1113, pp 51-4) LATTICE VIBRATION OF DISORDERED LATTICES AND NEUTRON SCATTERING. Toda, M. (In Japanese and English).

When an atom in a crystal is replaced by a light impurity, a localized vibration of the impurity atom and the neighboring atoms can take place. There are cases in which localized vibration is observed by inelastic scattering of neutrons. Vibration of high polymers was observed by inelastic scattering of neutrons; the effect due to imperfection of the crystals is reported. (auth)

16963 (JAERI-1113, pp 76-80) FERROELECTRIC PHASE TRANSITION AND NEUTRON INELASTIC SCATTERING. Yamada, Y. (In Japanese and English).

The theoretical and experimental studies previously performed on the mechanism of ferroelectric phase transitions are briefly reviewed for both the displacive-type and the order–disorder-type ferroelectrics. Several points which are of physical interest and have not yet been checked experimentally are pointed out, and some probable experiments with the inelastic neutron-diffraction technique to elucidate these points are discussed. (auth)

16964 (JAERI-1113, pp 81-3) ON THE PHASE TRANSITION OF CRYSTALS. Hoshino, S. (In Japanese and English).

Some problems in the study of phase transitions of crystals by measurements of neutron scattering are discussed. The importance of a preliminary study by x-ray diffraction measurements for some ferroelectric crystals such as $BaTiO_3$ and $NaNO_2$ is described. The dispersion relation of lattice vibration due to the lowest-frequency optical mode for $BaTiO_3$, obtained from the measurement of diffuse x-ray scattering, is shown. A characteristic behavior of the phase transition of $NaNO_2$ in the vicinity of the transition point is explained. A possibility for the study of the phase transitions of some other crystals such as HCl, HBr, HI, AgI, CuI, and Ag_2HgI_4 by measurements of neutron inelastic or quasi-elastic scattering is proposed. (auth)

16965 PHONON DISPERSION RELATIONS FOR BERYLLIUM METAL. Koppel, J. U. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Maradudin, A. A. Phys. Lett., 24A: 244-5(Feb. 27, 1967).

Phonon dispersion curves are calculated for beryllium using the free electron approximation for the dielectric screening function. A comparison of the theoretical results with the experimental results of Schmunk et al. is presented. (auth)

16966 KINETICS OF COMPLEX DEFECT ANNEALING IN SILICON. Fang, P. H. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Lett., 24A: 251-2(Feb. 27, 1967).

The proposed phenomenological model of the annealing of complex defects induced in Si is based on two assumptions: (1) first order kinetics, and (2) dependence of the annealing activation energy on the instantaneous concentration of defects. Predictions of the model are compared with experimental data on the dependence of residual damage and recovery time on the integrated flux of 1-MeV electrons. There is qualitative agreement. (A.G.W.)

16967 PROTON-IRRADIATION STUDY OF PULLED AND FLOAT-ZONE SILICON SOLAR CELLS. Tauke, R. V.; Faraday, B. J. (Naval Research Lab., Washington, D. C.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 234-5(Feb. 1967).

A comparison of the photovoltaic properties of pulled and float-zone silicon n-on-p solar cells exposed to 4.6-MeV protons at 30°C showed that differences in the residual oxygen impurity did not play a major role in the radiation-induced damage. (auth)

16968 ELECTRON EMISSION OF INTERMETALLIC COMPOUNDS BY ION BOMBARDMENT. I. STUDY ON ACTIVATED AND UNACTIVATED CuBe. Baumhaekel, Rolf (Univ., Cologne). Z. Phys., 199: 41-55(1967). (In German).

The secondary electron yield γ of activated CuBe in bombardment with Ag^+, Ne^+, Ar^+, Kr^+, and Xe^+ ions in the energy range from 0.3 to 3 keV is about 300% higher than the yield γ of un-

activated CuBe. The yield increase previously unobserved is assigned to a semiconducting surface character of the activated CuBe. The secondary electron yield δ in electron bombardment is used as a measurement of the activation. In reference to the application in multipliers, continuous bombardment shows that the activated layer was disturbed under long-time charges. (tr-auth)

16969 ELECTRON EMISSION OF INTERMETALLIC COMPOUNDS BY ION BOMBARDMENT. II. STUDY OF CESIUM–ANTIMONY FILMS. Baumhaekel, Rolf (Univ., Cologne). Z. Phys., 199: 56-67(1967). (In German).

The secondary electron yields γ of Cs_3Sb layers under bombardment with He^+, Ne^+, and Ar^+ ions attain high values, which slowly decay after several days because of the instability of the films. The yields γ of Cs_2Sb are time-constant, but slight. The simultaneously determined work functions of the films are 1.36 and 1.96 eV for Cs_3Sb and Cs_2Sb, respectively. The energy distributions of the secondary electrons show pointed high maxima under 1 eV and a remarkably low contribution of fast electrons. (tr-auth)

16970 LOCATION OF INERT GAS ATOMS IN KCl, CaF_2, AND UO_2 CRYSTALS BY H^+ AND He^{2+} "CHANNELING" STUDIES. Matzke, Hj.; Davies, J. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Appl. Phys., 38: 805-8(Feb. 1967).

The α-particle emission rate of ^{222}Rn, embedded in single crystals of KCl, CaF_2, and UO_2 at a concentration of 10^{-4} to 10^{-3} at. %, exhibits no detectable anisotropy— thereby proving that the radon atoms do not occupy single lattice vacancies and also, in the case of the fluorite structures, CaF_2 and UO_2, that they do not occupy the big interstitial holes either. The α-emission rate of the short-lived daughter isotopes (^{218}Po and ^{214}Po) also exhibits no anisotropy in the KCl, and CaF_2 experiments. In UO_2, however, the polonium α-peaks are attenuated markedly within $0.8 \pm 0.2°$ of the ⟨100⟩ direction, indicating that the Po atoms are located along the ⟨100⟩ lattice row. Similarly, wide-angle Rutherford scattering of protons was used to show that Xe, embedded in KCl at a concentration of 0.2 at. %, does not occupy single lattice vacancies. (auth)

16971 EQUIATOMIC BINARY COMPOUNDS OF Zr WITH TRANSITION ELEMENTS Ru, Rh, AND Pd. Wang, Frederick E. (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 38: 822-4(Feb. 1967).

By means of single-crystal x-ray-diffraction methods, an underlying structural similarity among ZrRu, ZrRh, and ZrPd was established. Further, based on the high-temperature x-ray photographs, the existence of an "M_s" transition for ZrRh at 380°C and an "M_f" transition for ZrPd at 550°C was confirmed. Based on this evidence, the existence of the unique "martensitic" transition "bands" can be visualized in the TiNi and ZrPd series of equiatomic binary compounds. (auth)

16972 TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS OF MOLYBDENUM. Dickinson, J. M.; Armstrong, P. E. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Appl. Phys., 38: 602-6(Feb. 1967). (LA-DC-8252).

The elastic properties of molybdenum single crystals were measured using thin-rod resonance techniques as a function of temperature from −198° to over +650°C. Molybdenum behaves in a normal manner over this temperature range. Its elastic stiffness coefficients, with the exception of C_{12} which increased 3%, decreased in a nearly linear manner. The decrease was 8% for C_{44}, 11% for C_{11}, and 18% for C'. From these data the temperature dependence of the bulk modulus, the shear coefficient C', the anisotropy ratio, and the Young's and shear modulus of isotropic polycrystalline molybdenum were calculated. (auth)

16973 THEORY OF ANOMALOUS INFRARED ATTENUATION IN NEUTRON-IRRADIATED COMPOUND SEMICONDUCTORS. McNichols, J. L.; Ginell, W. S. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). J. Appl. Phys., 38: 656-60(Feb. 1967).

It is proposed that the anomalous infrared attenuation observed in neutron-irradiated compound semiconductors is the result of an induced local phase change to a metallic-like state. The total infrared scattering and absorption for a distribution of small metallic inhomogeneities in an otherwise uniform nonmetallic crystal is shown to produce attenuation which is proportional to the square of photon energy in the band gap. Application is made to fast-neutron-irradiated GaAs and agreement with reported data is found to be excellent. It is suggested that further investigation of the anomalous, structureless infrared attenuation observed for some irradiated compound semiconductors may lead to more quantitative understanding of spike phenomena in these materials. (auth)

16974 POINT-DEFECT STUDIES IN PLATINUM BY ELECTRON IRRADIATION AT LOW TEMPERATURES. I. DEFECT PRODUCTION. Bauer, Walter; Goeppinger, W. F. (Atomics International, Canoga Park, Calif.). Phys. Rev., 154: 584-8 (Feb. 15, 1967).

The electrical resistivity increase per unit electron flux (damage rate) of 99.999%-pure 0.0002-in.-thick platinum foils was measured as a function of incident electron energy from 1.3 to 2.1 MeV near 9°K. Reasonable agreement between the theoretical displacement cross section, calculated with a unit displacement probability, and experimental data is achieved with an effective threshold displacement energy of 36 eV and a Frenkel resistivity of 6×10^{-4} Ω cm per unit fractional concentration Frenkel pairs. The ratio of the damage rate of platinum to that of gold is nearly independent of the electron energy for $45 \text{ eV} < T_m < 72$ eV and decreases rapidly to zero for $T_m < 45$ eV, where T_m is the maximum energy imparted to a lattice atom by a bombarding electron. These results are interpreted to indicate that indirect displacement processes occur in both metals near threshold. (auth)

16975 POINT-DEFECT STUDIES IN PLATINUM BY ELECTRON IRRADIATION AT LOW TEMPERATURES. II. RESISTIVITY RECOVERY FROM 10 TO 300°K. Bauer, Walter; Goeppinger, W. F. (Atomics International, Canoga Park, Calif.). Phys. Rev., 154: 588-96(Feb. 15, 1967).

Pairs of 99.999%-pure platinum wires were irradiated with equal doses below 10°K and annealed simultaneously. The recovery spectrum of both wires was closely identical. However, when one of the wires was quenched prior to the irradiation, the irradiation-damage recovery was remarkably different from that of the unquenched wire: The ratio of the rate of recovery of the quenched to the unquenched wire was nearly 1 from 10 to 24°K, near 2 from 24 to 27°K, and near 0 from 28 to 32°K. The amount of recovery of the quenched sample was enhanced 7% over the unquenched sample. These results are strong evidence for long-range (uncorrelated) migration of an interstitial near 28°K. Only a few percent recovery takes place in either the quenched or the unquenched sample between 35 and 300°K. These observations, combined with other relevant experimental results and calculations based on chemical rate theory, provide evidence that the defects remaining above 35°K are mainly trapped interstitials, di-interstitials, and vacancies. Stage III is due to the release of trapped interstitials and the migration (or dissociation) of dimers. The vacancies migrate near 600°K (stage IV). (auth)

16976 FLUORESCENT DECAY TIMES OF EXCITONS BOUND TO ISOELECTRONIC TRAPS IN GaP AND ZnTe. Cuthbert, J. D. (Bell Telephone Labs., Whippany, N. J.); Thomas, D. G. Phys. Rev., 154: 763-71(Feb. 15, 1967).

An investigation of the radiative decay times of bound excitons in GaP:N, GaP:Bi, and ZnTe:O is reported. New experimental techniques involving the use of a pulsed Van de Graaff generator for exciting the samples in liquid refrigerants are described. In each material, decay to the ground state of the electronic complex can occur through either an allowed (A) or forbidden (B) transition. A study of the temperature dependence of the kinetics permits the individual decay components, τ_A and τ_B, to be separated. For each material, these quantities are used to calculate the oscillator strengths of the transitions, and a value for $N/\alpha_0(A)$, where N is the density of impurities, and $\alpha_0(A)$ the value of the absorption coefficient at the A line. Agreement is found with independent measurements of $N/\alpha_0(A)$ in GaP:N and GaP:Bi. The values of τ_B/τ_A substantiate a proposed classification of the impurities into isoelectronic donors and acceptors. In ZnTe:O, a mechanism is proposed to account for the approximately constant fluorescent efficiency and anomalous increase in decay time with increasing temperature in the range 30 to 300°K. In each material, the luminescence quenches at higher temperatures, and the simultaneous decrease in decay time enables activation energies and capture cross sections to be determined. (auth)

16977 $^2P_{\frac{1}{2}} \rightarrow {}^2P_{\frac{3}{2}}$ TRANSITIONS OF Tl^0 IN ALKALI-HALIDE CRYSTALS. Delbecq, Charles J.; Ghosh, Amal K.; Yuster, Philip H. (Argonne National Lab., Ill.). Phys. Rev., 154: 797-8 (Feb. 15, 1967).

Tl^0 has been produced in KCl–TlCl, KBr–TlBr, and KI–TlI crystals at 77°K by exposure to γ rays, and two absorption bands attributed to forbidden transitions between the $^2P_{\frac{1}{2}} \rightarrow {}^2P_{\frac{3}{2}}$ levels have been measured. In KCl–TlCl, the oscillator strength, band shape, and peak positions have been determined at 153, 77, and 5°K. (auth)

16978 OPTICAL PROPERTIES OF SOME F-AGGREGATE CENTERS IN LiF. Nahum, J.; Wiegand, D. A. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 154: 817-30(Feb. 15, 1967).

Detailed studies have been made of the emission and associated excitation and absorption spectra of x-irradiated LiF. By studies of changes in the spectra during periods in the dark and during subsequent reirradiation, and by use of the Mollwo–Ivey relationships, it has been possible to identify optical bands associated with the F_2^+ and the F_3^+ centers. The F_2^+ center has an absorption band at 645 mμ and an emission band at 910 mμ, while the F_3^+ center has an absorption band at 458 mμ and an emission band at

528 mμ. The F_3^+ absorption band (458 mμ) is one of several bands underlying the M band (441.2 mμ). It has been possible to induce transformations from the ionized F-aggregate centers to the F-aggregate centers, but it has not been possible to bring about the reverse transformations. The vibrational frequency as determined from the temperature dependence of the half-width of the pure M band was found to be close to the frequencies obtained from other bands. This result suggests that the centers associated with these bands are all interacting with the same normal lattice modes. (auth)

16979 INFLUENCE OF DEFORMATION ON THE COLORABILITY OF KCl. Sibley, W. A.; Russell, J. R. (Oak Ridge National Lab., Tenn.). Phys. Rev., 154: 831-8(Feb. 15, 1967).

A study of the radiation-temperature and -intensity dependence of the colorability of deformed pure and calcium-doped KCl crystals was made. It was found that the deformation-induced enhancement of the coloration was greater for low-intensity than for high-intensity radiation. Moreover, it was determined that annealing at 25°C after deformation and prior to irradiation had no effect on the enhanced colorability. There is a small increase in the F-center growth curves of deformed samples compared to undeformed ones for irradiations at 77°K. The results suggest that the primary source of the enhanced coloration is dislocation dipoles created during deformation. (auth)

16980 STUDY OF IONIZATION-INDUCED RADIATION DAMAGE IN MgO. Chen, Y.; Sibley, W. A. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Rev., 154: 842-50 (Feb. 15, 1967). (ORNL-P-2478).

A study of the 2.3-eV absorption band in MgO crystals irradiated with electrons and gamma rays at 7, 80, and 305°K has been made. This broad band, designated as V_1, has a half-width of 0.96 eV at 5 and 78°K and could be optically bleached even at liquid-helium temperature. When specimens were bleached with polarized light, it was found that there was no dichroism in any of the ⟨100⟩, ⟨110⟩, or ⟨111⟩ directions at 5°K. The colorability of the crystals was strongly dependent on their thermal treatment. The concentration of centers responsible for the 2.3-eV absorption could be enhanced by quenching the crystals from high temperature prior to irradiation and could be suppressed by slow cooling of the specimens to room temperature. The effects of these heat treatments were found to be reversible. The presence of certain impurities in the crystals was observed to suppress the 2.3-eV coloration, but no correlation between the Fe^{3+} concentration or the total Fe concentration and the maximum coloration in a quenched crystal was observed. The afterglow luminescence was also surveyed in the energy range 1.3 to 5.0 eV. (auth)

16981 ELECTRON-NUCLEAR DOUBLE RESONANCE OF F CENTERS IN MgO. Unruh, Wesley P. (Ohio Univ., Athens); Culvahouse, J. W. Phys. Rev., 154: 861-6(Feb. 15, 1967).

Electron-nuclear double-resonance measurements on F centers in MgO are reported. From these measurements, the magnetic and electric hyperfine interaction constants for sites with one nearest-neighbor ^{25}Mg nucleus are obtained with high precision. It is found that: for the isotropic hyperfine-interaction constant, $A/h = 11.03 \pm 0.02$ MHz; for the dipolar interaction constant, $B/h = 1.33 \pm 0.02$ MHz; for the quadrupole interaction constant, $e^2qQ/h = 5.64 \pm 0.01$ MHz. From the quadrupole interaction constant, it is shown that the Mg nuclei relax outward from the vacancy by an amount between 0.04 and 0.08 times the Mg–O distance. The value of e^2qQ for ^{87}Sr leads to similar conclusions regarding the relaxation of nearest-neighbor nuclei of the F center in SrO. (auth)

16982 CORRELATION OF THE OPTICAL AND ELECTRON-SPIN-RESONANCE ABSORPTIONS OF THE H CENTER IN KCl. Delbecq, Charles J.; Kolopus, James L.; Yasaitis, Edward L.; Yuster, Philip H. (Argonne National Lab., Ill.). Phys. Rev., 154: 866-71(Feb. 15, 1967).

It has been shown that the optical H band and the ESR H spectrum arise from the same center, the H center, in KCl. Similar to the Cl_2^- (or V_K) center, the H center has two optical transitions: A strong and highly σ-polarized transition giving rise to an absorption band at 336 nm, and a much weaker transition, which is very weakly σ-polarized, giving rise to an absorption band at 522 nm. The disorientation temperature of the H center has been found to be (10.9 ± 0.3)°K. (auth)

16983 LOW-TEMPERATURE THERMAL CONDUCTIVITY OF FAST-NEUTRON-IRRADIATED SILICON AND GERMANIUM. Albany, H. J.; Vandevyver, M. (CEN, Saclay, Gif-sur-Yvette, France). J. Appl. Phys., 38: 425-30(Feb. 1967).

The thermal conductivity K of initially n-type silicon and germanium irradiated at about 30°C at four fast-neutron doses (1.1×10^{17}, 2.5×10^{17}, 1.7×10^{18}, and 3.4×10^{18} n/cm²) was measured between 5 and 300°K. The thermal-conductivity behaviors of the two irradiated materials differ by significant features: Pronounced shifts of the maximum of K to higher temperatures are observed in germanium after irradiations, leading to a depression of K which is more pronounced below than above the maximum. No noticeable shift, however, appears in silicon after bombardment, the depressions of K on both sides of the peak remaining comparable. The additive thermal resistivity ($K^{-1} - K_0^{-1}$) at 20°K is found to increase with the integrated flux ϕ, approximately as $7.9 \times 10^{-13}\ \phi^{0.85}$ cm·deg/W, and $3.8 \times 10^{-12}\ \phi^{0.65}$ cm·deg/W, for irradiated silicon and germanium, respectively. Similar flux dependences were observed by Vook for 2-MeV electron-irradiated silicon and germanium. Using the Callaway model, it is shown that the experimental data for irradiated silicon can be accounted for by considering only an increase in the $\tau^{-1} = A'\omega^4$ scattering, the factor A' increasing linearly with the flux. The additional scattering mechanism is most likely to be associated with strain fields arising from bombardment-induced defects instead of an electron–phonon interaction, unless one assumes for the latter a Rayleigh-type scattering law. In agreement with Vook's results on electron-irradiated germanium, the dominant additional scattering in the present irradiated germanium, at least for the lower doses, appears to be due to electron–phonon interaction. On the basis of the Keyes model, the difference between bombardment-induced scatterings in silicon and germanium is attributed to the predominant effects of irradiation in these materials, silicon approaching an intrinsic behavior and germanium becoming highly p type. (auth)

16984 THRESHOLD ENERGY FOR THE DISPLACEMENT OF ATOMS IN GRAPHITE. Montet, G. L. (Argonne National Lab., Ill.). Carbon, 5: 19-23(Feb. 1967).

The energy required to displace a carbon atom from its normal lattice site was determined directly by study of the lattice vacancies resulting from the displacement process. Annealed natural crystals of graphite containing less than 10^{-10} vacancies per carbon atom were irradiated at room temperature with electrons of selected energies in the range from 100 to 500 keV. Examination of crystals irradiated with electrons of energies less than 150 keV showed that these irradiations produced no vacancies, whereas examination of crystals irradiated with electrons of energies exceeding 160 keV revealed a production of vacancies. From these observations it may be concluded that the threshold energy for displacement in graphite is approximately 33 eV. (auth)

16985 ENERGY DISTRIBUTIONS OF LOW-ENERGY ELECTRONS SCATTERED FROM [100] FACES OF NaCl AND KCl. Kelly, J. C.; Lynch, D. F. (Univ. of New South Wales, Kensington). Solid State Commun., 5: 37-40(Jan. 1967).

Retarding-field energy spectra were obtained for low energy electrons scattered from [100] faces of NaCl and KCl. The results are in agreement with previous measurements of characteristic electron energy losses obtained at higher incident electron energies. No losses characteristic of surface states were observed. The need for small scattering angle experiments rather than the usual hemispherical collector method is demonstrated. (auth)

16986 ANISOTROPY AND PHASE TRANSITION EFFECTS IN NEUTRON SCATTERING FROM KH_2PO_4. Imry, Y.; Pelah, I.; Wiener, E.; Zafrir, H. (Soreq Nuclear Research Center, Yavne, Israel). Solid State Commun., 5: 41-4(Jan. 1967).

The total neutron cross-section per molecule of single KDP crystals was measured by a time-of-flight method. Results for the two principal crystalline directions are presented as a function of neutron energy and temperature, and are consistent with the existence of proton tunneling modes along the hydrogen bonds. (auth)

16987 SPECIFIC HEAT AND MAGNETIC SUSCEPTIBILITY OF DILUTE SOLID SOLUTIONS OF YTTRIUM–GADOLINIUM. Allain, Y.; Bonnerot, J.; Caroli, B.; Coqblin, B.; Jesser, R.; Raphael, G. J. Phys. (Paris), 28: 98-106(Jan. 1967). (In French).

Measurements of the specific heat and the magnetic susceptibility of yttrium solid solutions with magnetic impurities of gadolinium are reported. The indirect interaction model of Ruderman–Kittel between ionic spins of gadolinium atoms can qualitatively explain the observed cooperative effects. Moreover, an f virtual bound-state model with spin and orbital decoupling is suggested to try to account for the apparently high values taken by the electronic term of the specific heat and by the magnetic moment. (auth)

16988 INVESTIGATION OF SMALL AMOUNT OF SUBSTANCE WITH EXOELECTRONS. Kramer, Johannes (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Angew. Phys., 22: 272-8(Mar. 1967). (In German).

Investigation of the surface of solid substances by exoelectrons after x-ray irradiation is considered. A rough calculation leads to

the lower limit of the sensitivity of 10^{-12} to 10^{-13} g. In this range the emission is a measure for the amount of the engaged emitting material. This can also be present as impurity within a nonemitting material. When the emitting substance is unknown, an identification can be obtained by the dependence of the emission on the conditions for irradiation and stimulation. The glow curve after irradiation is the most simple and secure way of identification. Another promising way is the change of sensitivity as a result of chemical processes. These measurements also can be carried out in the range between 10^{-12} and 10^{-6} g. An expansion of the limits in both directions can be expected. (auth)

16989 INFLUENCE OF THERMAL VIBRATIONS OF THE CRYSTAL LATTICE ON THE COEFFICIENT OF SECONDARY EMISSION OF ELECTRONS BY IONS. Evdokimov, I. N.; Molchanov, V. A.; Odintsov, D. D.; Chicherov, V. M. (Lomonosov State Univ., Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 2348-52(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2939-44(Oct. 1966).

An investigation was made of the dependence of the coefficient of secondary electron emission by ions, γ, on the angle of incidence of ions on the target φ, at temperatures of 200 and 900°C for various orientations of a copper single crystal, and of a polycrystalline copper target bombarded with $(^{20}Ne)^+$, $(^{40}Ar)^+$, and $(^{84}Kr)^+$ ions of about 30 keV. It was found that γ was practically constant for the polycrystalline target when the target temperature was varied (for fixed angles of incidence of ions on the target). An increase in temperature of the single-crystal target led to a decrease in the emission coefficient anisotropy. The change in the form of the curve was different for different orientations of the target. The results obtained were described well by the transparency model. (auth)

16990 THEORY OF DIFFUSIONAL BROADENING OF THE MOESSBAUER LINE IN NONIDEAL CRYSTALS. Krivoglaz, M. A.; Repetskii, S. P. (Shevchenko State Univ., Kiev). Soviet Phys.-Solid State (Engl. Transl.), 8: 2325-32(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2908-18(Oct. 1966).

The effect of diffusional motion of interstitial atoms on the Mössbauer spectra of nuclei (of either host or impurity atoms) located at lattice sites and not directly participating in the diffusion is studied. It is shown that the static stress created by the interstitial atoms leads at high temperatures to an attenuation of the Mössbauer line intensity and to the appearance of an additional broader spectral distribution. It follows from some estimates that these effects can be significant even for fairly low concentrations and, in principle, they could be used to study the static distortion and diffusional motion of interstitial atoms, particularly near impurity atoms. Consideration is given to the influence of diffusion on the concentrational broadening of Mössbauer spectra and the narrowing of the lines at high temperature. (auth)

16991 CONCERNING THE THEORY OF DYNAMIC POLARIZATION AND RELAXATION OF NUCLEI IN THE CASE OF STRONG SATURATION. Bendiashvili, N. S.; Buishvili, L. L.; Zviadadze, M. D. (Inst. of Cybernetics, Academy of Sciences, Tbilisi, Georgian SSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 2333-6(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2919-24(Oct. 1966).

The relaxation and dynamic polarization of nuclei caused by paramagnetic impurities has been examined on the basis of quantum statistics for the case when an intense radiofrequency field is applied to the system of electron spins. (auth)

16992 KINETIC EQUATIONS FOR QUADRUPOLE RESONANCE OF A SPIN-3/2 NUCLEUS. Kessel, A. R.; Korchemkin, M. A. (Kazan Physicotechnical Inst.). Soviet Phys.-Solid State (Engl. Transl.), 8: 2344-7(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2934-8(Oct. 1966).

It is shown that if certain conditions are imposed on the internal crystal field or on the orientation of the externally applied magnetic field, relative to the crystal axes, quadrupole resonance of spin $^3/_2$ nuclei is described by a system of three equations. In contrast to the well-known Bloch equation for nuclear magnetic resonance, these equations simultaneously determine the motion of the electric quadrupole and magnetic dipole moments of the nucleus. (auth)

16993 CONCERNING THE KINETICS OF IMPURITY PHOTOCONDUCTIVITY IN SILICON CONTAINING RADIATION DEFECTS. Gerasimov, A. B.; Konovalenko, B. M.; Kotina, I. M.; Umarova, Kh. F. (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 2390-3(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 2994-8(Oct. 1966).

Unusual kinetics for the growth of impurity photoconductivity have been observed at 77°K in silicon containing radiation defects. An explanation of the kinetics based on the bipolar character of impurity excitation is offered and the results of an approximate calculation of the kinetics of the inverse charge-transfer process are presented for the case of low-level excitation. The capture cross section of holes by the radiation defect levels at $E_c - 0.40$ eV is determined. (auth)

16994 EFFECT OF ANNEALING ON DISLOCATION MOBILITY IN IRRADIATED LiF CRYSTALS. Berzina, I. G.; Gusev, E. B.; Shaskol'skaya, M. P. (Inst. of Steels and Alloys, Moscow. All-Union Scientific-Research Inst. for Geophysics and Geochemistry, Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 2410-12(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 3019-21(Oct. 1966).

The effect of various color centers on dislocation mobility and structure of star-shaped etch patterns on (100) faces of LiF crystals is considered. It is shown that the formation process and dimensions of these star-shaped etch patterns during an isothermal anneal can be divided into three stages corresponding to the destruction of different types of defect. The formation time depends on the radiation dose. (auth)

16995 CONCERNING THE THEORY OF BROADENING OF FORBIDDEN RESONANCE. Buishvili, L. L.; Vatova, L. B. (Inst. of Cybernetics, Academy of Sciences, Tbilisi, Georgian SSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 2453-5(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 3075-8(Oct. 1966).

Exchange interaction between electron spins causes a broadening of forbidden resonance lines. The second and fourth moments corresponding to this interaction are calculated and the ratio of the fourth moment to the second is evaluated. (auth)

16996 DETERMINATION OF THE ENERGY OF SEPARATION OF AN ELECTRON–HOLE PAIR IN CdS SINGLE CRYSTALS DURING IRRADIATION BY 5 TO 50-keV ELECTRONS. Malyuk, N. F.; Fedorus, G. A.; Fursenko, V. D.; Shakh-Melikova, I. A.; Sheinkman, M. K. (Inst. of Semiconductors, Kiev). Soviet Phys.-Solid State (Engl. Transl.), 8: 2513-14(Apr. 1967).

Translated from Fiz. Tverd. Tela, 8: 3133-5(Oct. 1966).

The average energy of separation of an electron–hole pair in CdS single crystals was determined by a method based on comparison of the steady-state values of the photoconductivity and the electron-induced conductivity for the same crystal. Single crystals having a special nonselective spectral characteristic of the photoconductivity were prepared by a special heat treatment for use in the determination. For electron energies in the range 5 to 50 keV, the average energy of separation was found to be 7.5 ± 0.8 eV. This result is in good agreement with the approximate theoretical model predicting a value close to three times the forbidden-band width. (A.G.W.)

16997 CHANGE IN THE MOESSBAUER SPECTRUM OF ^{125m}Te IN THE SEMICONDUCTOR PbTe FOLLOWING IRRADIATION IN A REACTOR. Stepanov, E. P.; Aleksandrov, A. Yu. (Kurchatov Atomic Energy Inst., Academy of Sciences, USSR). Inst. of Chemical Physics, Academy of Sciences, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 83-4(Feb. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 101-3(Feb. 1, 1967).

A ^{125}Te source was prepared by irradiating a Pb^{124}Te sample in a reactor neutron flux. Moessbauer spectrum measurements showed that the source obtained had a clearly pronounced isomeric shift relative to the PbTe absorber; the shift decreased with time. The change in the isomeric shift is described by the exponential function $\delta = \delta_0 \exp(-t/\tau)$, where $\tau = 10 \pm 3$ days. It is suggested that the observed isomeric shift is due to structure defects produced during irradiation. (A.G.W.)

16998 THEORY OF X-RAY RAMAN SCATTERING. Mizuno, Yukio (Tokyo Univ.); Ohmura, Yoshihiro. J. Phys. Soc. Jap., 22: 445-9(Feb. 1967).

Inelastic scattering of x rays by localized electrons, such as K electrons, in solids is treated theoretically. The wave length of x rays is chosen to be longer than the orbital radius of localized electrons, but still short enough so that the photon energy is much higher than the ionization energy. On the basis of reasonable approximations, it is found for polycrystals that the differential cross section is proportional to $\nu_0^4 t(\nu_0 - \nu)(1 + \cos^2\theta)\sin^2(\theta/2)$. Here ν_0 and ν are respectively the frequencies of the incident and scattered x rays, θ being the scattering angle. $\nu t(\nu)$ is a quantity proportional to the cross section of absorption of the x rays with frequency ν by the same electrons. The expression has recently been confirmed experimentally. (auth)

16999 MAGNETIC HYPERFINE FIELD AT THE ^{160}Dy NUCLEUS FOLLOWING ^{160}Tb β DECAY AND THE ELECTRON CORRELATION TIME OF RARE EARTH IONS IN THE VARIOUS GARNETS. Ray, Frederic Duane. Philadelphia, Univ. of Pennsylvania, 1966. 113p.

Thesis.

A measurement of the rotation and attenuation of the angular correlation of gamma rays successively emitted from an excited nucleus allows a determination of the large effective magnetic hyperfine fields and the fast electron relaxation times present in the rare-earth ions in the garnets. The time-average magnetic hyperfine field $\langle H_{int}^{+} \rangle$ at the ^{160}Dy nucleus following β decay from ^{160}Tb was measured by this technique as a function of temperature and was compared to molecular-field-type calculations for $\langle H_{int}^{+} \rangle$ in Tb^{3+} and Dy^{3+}. At higher temperatures where crystalline field effects are known to be small, the experimental values agree well with the internal field calculated for the electron configuration of the Tb^{3+} ion without crystalline fields. The daughter ion has therefore not acquired an additional electron from the surrounding garnet structure to become Dy^{3+} during the 3-nanosec lifetime of the intermediate nuclear state. At room temperature, $\langle H_{int}^{+} \rangle$ for Tb^{3+} in LuIG was measured as (495 ± 50) kOe. Deviations of the experimental values from the calculated values below room temperature indicate the significance of crystalline fields in that temperature range. The correlation time (α relaxation time) measurements as a function of temperature indicate that for Tb^{3+} in garnets a saturation process occurs between 200 and 300°K which causes the relaxation time to remain constant to much higher temperatures. It is possible that the temperature insensitivity of the relaxation time at higher temperatures is due to the fact that the transitions which determine the relaxation time of the Tb^{3+} ions occur between closely spaced energy levels. Experimental data indicate that other levels do not become important for Tb^{3+} for temperatures at least up to 575°K in LuIG and up to 1100°K in LuGaG. The onset of saturation in the same temperature range for both magnetic and nonmagnetic materials indicates the small separation in the energy levels involved in the relaxation is nearly the same in both cases. It occurs at a relaxation time of $\sim 10^{-11}$ sec, which is longer than is observed in either Sm^{3+} ($\sim 3 \times 10^{-12}$ sec) or Tm^{3+} ($\sim 4 \times 10^{-13}$ sec) at room temperature. Experiments were carried out to compare the correlation time of the Tb^{3+} ion in magnetic and nonmagnetic garnets. No definitive conclusion was possible at 78°K; and at higher temperatures, saturation, which depends only on the separation of the energy levels involved in the relaxation process, has started and therefore no information about the dynamic relaxation process is obtainable. Experiments were also carried out at room temperature to compare the relaxation of Sm^{3+} and Tm^{3+} ions in the two types of garnet. No difference was observed in the correlation time of either ion in the two types of garnet so it is concluded that the magnetic mechanisms make no significant contribution at room temperature. (Diss. Abstr.)

Theoretical Physics

17000 NON-ANALYTIC SPINOR REPRESENTATION OF 4-DIMENSIONAL LORENTZ TRANSFORMATION. Ghosh, N. N. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 40: 471-4(Aug. 1966).

A representation of a 4-dimensional Lorentz transformation is given by utilizing the complex transformation coefficients of a unimodular unitary spinor transformation defined in a nonanalytic complex space S_2. The treatment is similar to that followed in an earlier paper where the spinor representation of 5-dimensional Lorentz transformation was considered. (auth)

17001 POWER ENERGY SPECTRUM OF COSMIC RAYS AS A SOLUTION OF THE GENERAL COVARIANT KINETIC EQUATION. Gordeev, A. N. Soviet Astron. AJ (Engl. Transl.), 10: 826-32(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 1030-8(Sept.-Oct. 1966).

The general relativity collisionless kinetic equation is solved, following a treatment developed by Vlasov; a power energy distribution is obtained. The macroscopic behavior of a system having such a distribution function is examined and the equation of state derived. Applied to cosmic rays, the solution yields an energy-spectrum exponent depending on the source temperature. (auth)

17002 PROBLEM OF TWO ROTATING SPHERICALLY SYMMETRIC BODIES IN GENERAL RELATIVITY. Kurmakaev, Z. Kh. (Astrophysical Inst., Academy of Sciences, Alma-Ata, Kazakh SSR). Soviet Astron. AJ (Engl. Transl.), 10: 822-5(Mar.-Apr. 1967).

Translated from Astron. Zh., 43: 1025-9(Sept.-Oct. 1966).

The translational motion of two rotating spherically symmetric bodies is treated by a method similar to that of Abdil'din. A Lagrangian is applied. Equations are derived for the secular variation of the two vectors describing the relative orbit and the corresponding parameters are evaluated. (auth)

17003 A SOLUBLE FERMI-GAS MODEL. VALIDITY OF TRANSFORMATIONS OF THE BOGOLYUBOV TYPE. des Cloizeaux, J. (CEN, Saclay, Gif-sur-Yvette, France). J. Math. Phys. (N. Y.), 7: 2136-44(Dec. 1966).

A linear soluble Fermi-gas model is used to test the validity of perturbation theory and the criteria of instability obtained by applying transformations of the Bogolyubov type. The model Hamiltonian describing the interaction of the electrons in a simple band is $H(\rho) = -\Sigma\ (\cos k + \rho) c_k^{+} c_k + \rho \Sigma \cos q\ c_{k+q}^{+} c_{r-q}^{+} c_r c_k$. For a half-filled band, the energies of the low-lying states are calculated exactly, by using previous results concerning a linear chain of spins with interaction. It is shown that perturbation theory must be valid for $-1 < \rho < 1$, and, for values of ρ belonging to this range, the slope of the specific heat for $T = 0$ is calculated by direct application of Landau's theory. On the other hand, anomalous Hartree–Fock states can be built for all values of ρ, by using transformations of the Bogolyubov type, and these states are more stable than the normal Hartree–Fock state. Thus, it appears that the Bogolyubov method may lead to completely erroneous interpretations, when the coupling constants are small. (auth)

17004 THE TIME-DEPENDENT GREEN'S FUNCTION FOR ELECTROMAGNETIC WAVES IN MOVING SIMPLE MEDIA. Compton, R. T. Jr. (Case Inst. of Tech., Cleveland). J. Math. Phys. (N. Y.), 7: 2145-52(Dec. 1966).

The problem of radiation from sources of arbitrary time dependence in a moving medium is treated. The medium is assumed to be lossless, with permittivity ϵ and permeability μ, and to move with constant velocity ∇ with respect to a given inertial reference frame xyz. It is shown how the Maxwell–Minkowski equations for the electromagnetic fields in the moving medium can be integrated by means of a pair of vector and scalar potential functions analogous to those commonly used with stationary media. The wave equation associated with these potential functions is derived, and a scalar Green's function is defined to satisfy the same type of equation, with a delta-function source term $\delta(\mathbf{r}-\mathbf{r}')\ \delta(t-t')$, and the casuality condition. The solution for the Green's function is derived in closed form, by means of a Fourier integral method. The resulting Green's function is useful not only for calculating the fields from arbitrary sources in moving media, but also for its pedagogical value. It is simpler to understand the phenomenon of Cherenkov radiation using this method than it is from the conventional approach to the Cherenkov problem. (auth)

17005 ASYMPTOTIC EXPANSIONS OF THE DIRAC DENSITY MATRIX. Grover, Richard (Univ. of California, Livermore). Contract W-7405-eng-48. J. Math. Phys. (N. Y.), 7: 2178-86 (Dec. 1966). (UCRL-14787).

Asymptotic expansions are derived for the density operator $\rho_N(x', x) = \sum_{n=1}^{N} \psi_n(x')\psi_n(x)$ for small and large values of the relative distance $x'-x$ with a WKB expansion for bound-state wavefunctions in a plane, one-dimensional potential. In addition to some previously obtained corrections, the particle-density expansion includes a number of steady and oscillating correction terms to the zero-order Thomas–Fermi density which are related to the more recently derived corrections of Payne and of Kohn and Sham. A convenient and accurate approximation to the density operator for all arguments is also obtained from the first two terms of the expansion for large relative distances. The expansions become inadequate in the vicinity of the classical turning point of the highest energy state, as illustrated by numerical comparisons with the exact-density operator for the quadratic potential. A novel method is described for summing a finite series of oscillating terms such as occur in the density operator. (auth)

17006 GRAVITATION IN FLAT SPACE–TIME. Scott, J. C. W. (Defence Research Telecommunications Establishment, Ottawa). Nature, 213: 767-8(Feb. 25, 1967).

Einstein's general theory of relativity deals quite differently with gravitational and electromagnetic fields. This paper suggests a more symmetrical treatment. Unlike Einstein's theory, it predicts that the speed of light remains constant even when measured across a gravitational field. (auth)

17007 REPRESENTATIONS OF THE HOMOGENEOUS GALILEI GROUP IN A SPHERICAL BASIS AND THE ASYMPTOTIC BEHAVIOR OF RELATIVISTIC SPECIAL FUNCTIONS. Voisin, Jacques (Univ., Bujumbura, Burundi. Syracuse Univ., N. Y.). Contract AT(30-1)-3399. J. Math. Phys. (N. Y.), 7: 2235-7(Dec. 1966). (NYO-3399-57).

The irreducible unitary representations of the Galilei group G_h are obtained in the base $|lm\rangle$ from their expression in the base $|q\rangle$ (Mackey's representation). The faithful representations are then considered as asymptotic expressions for the representation matrices of the principal series of the Lorentz group. (auth)

17008 FACTORIZATION THEOREMS. Chester, G. V.; Sykes, J. (Cornell Univ., Ithaca, N. Y.). J. Math. Phys. (N. Y.), 7: 2243-50(Dec. 1966).

A precise set of conditions is given for which the momentum correlation functions of quantum mechanical, weakly interacting, many-particle systems can be factorized. (auth)

17009 SOLUTION OF THE EINSTEIN FIELD EQUATIONS WHICH CAN BE EMBEDDED IN A FLAT FIVE-DIMENSIONAL SPACE. Stephani, H. (Univ., Jena, Ger.). Commun. Math. Phys., 4: 137-42(Jan. 12, 1967). (In German).

Solutions of the Einstein equations which can be embedded in a flat five dimensional space are studied, without referring to the explicit form of the embedding. Those describing the gravitational field of a perfect fluid or an electromagnetic null field are invariantly characterized; in some special cases the metric is fully determined. (auth)

17010 NONEXISTENCE OF TROUSER-WORLDS. Kundt, Wolfgang (Univ., Hamburg). Commun. Math. Phys., 4: 143-4 (Jan. 12, 1967).

Simple restrictions are derived on the global structure of normal hyperbolic Riemannian spaces. As a consequence, cosmological models of the trouser type are ruled out irrespective of field equations. (auth)

17011 REMARKS ON BOSON COMMUTATION RULES. Itzykson, C. (CEN, Saclay, Gif-sur-Yvette, France). Commun. Math. Phys., 4: 92-122(Jan. 12, 1967).

A group theoretical derivation is given of Bargmann's representation of the boson commutation rules in a Hilbert space of analytic functions. Several interesting problems arise in the study of the global representation of the canonical group $S_p(2n,R)$. As a by-product, Laguerre polynomials as spherical functions on the nilpotent Weyl group are recovered. (auth)

17012 QUANTUM-STATISTICAL DISTRIBUTION FUNCTIONS OF A HARD-SPHERE SYSTEM. Nisteruk, C. J.; Isihara, A. (State Univ. of New York, Buffalo). Phys. Rev., 154: 150-9 (Feb. 5, 1967).

The singlet and pair distribution functions of a hard-sphere fluid are evaluated. Diagrams in various orders in the hard-sphere diameter α are analyzed. The pseudopotential and the binary-kernel methods are compared. At low temperatures the contribution from chain diagrams is evaluated explicitly in terms of the modified Bessel and Struve functions. These chain diagrams are important at large distances or at low energy. At short distances, first-order diagrams have to be examined, and classical and quantum-mechanical cases are treated. (auth)

17013 DENSITY EXPANSION OF QUANTUM TRANSPORT COEFFICIENTS. Weinstock, Jerome (Environmental Science Services Administration, Boulder, Colo.). Phys. Rev., 154: 210-? (Feb. 5, 1967).

A formal density expansion of transport coefficients expressed in terms of momentum autocorrelation functions is derived for a degenerate quantum (Bose–Einstein or Fermi–Dirac statistics) at any frequency and for noncentral as well as central forces. The result to lowest order in density is reduced to the solution of a well-defined quantum two-body problem, and the first density correction is reduced to the solution of a well-defined quantum three-body problem. It is confirmed that at zero frequency one only needs the asymptotic forms of the collision operator to calculate quantum transport coefficients. It is further pointed out that the coefficients of the third- and higher-order terms of the density expansion diverge at zero frequency, in analogy with the classical case. A "renormalization" is suggested, which, it is believed, leads to a nonanalytic density dependence for quantum gases distinct from the nonanalytic behavior associated with degeneracy statistics. (auth)

17014 EQUATIONS OF SPINOR FIELDS DEDUCED FROM UNIQUE LAGRANGIAN. I. Udeschini Brinis, Elisa. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 577-85 (Apr. 1966). (In Italian).

A symmetric second-rank spinor is shown to be expressible by one potential spinor with one dotted and one undotted index. This result allows one when considering a general field defined by a second-rank symmetric spinor and by its complex conjugate, to derive all field equations from a variational principle, by varying the potential spinor and its complex conjugate. (auth)

17015 MULTITEMPORAL THEORY OF RELATIVITY AND ITS APPLICATIONS TO QUASARS AND TO ELEMENTARY PARTICLES. Kalitzin, Nikola St. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 207-51(1966).

The need of a new theory of relativity for the study of quasars and elementary particles is briefly outlined. A multitemporal special theory of relativity, electrodynamics in space E_{3+3}, generalization of Dirac's equation in the spaces E_{3+3} and E_{3+3}, and collapse in the multitemporal theory of relativity are discussed in detail. (W.D.M.)

17016 EQUATIONS OF SPINOR FIELDS DEDUCED FROM UNIQUE LAGRANGIAN. II. Udeschini Brinis, Elisa. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 828-32 (May 1966). (In Italian).

In paper I a symmetric second-rank spinor was shown to be expressible by one potential spinor with one dotted and one undotted index. This result allowed one when considering a general field defined by a second-rank symmetric spinor and by its complex conjugate, to derive all field equations from a variational principle, by varying the potential spinor and its complex conjugate. By choosing the Langrangian density in a suitable way, Maxwell's equations in spinor form and Dirac equations for particles of spin one are derived. (auth)

17017 GEODESIC MOTION IN GRAVITATIONAL FIELDS. I. INTERNAL SCHWARZSCHILD FIELD. Kuchowicz, B. (Univ. of Warsaw). Acta Phys. Pol., 30: 981-97(Dec. 1966).

The motion of a test body with given mass, energy, and angular momentum in an incompressible fluid sphere is studied within the framework of general relativity. Conditions for the physical parameters of the test body are derived under which the motion is of a bounded type. It is found that for some choice of the physical parameters there exist two regions wherein particle motion is admitted. These two regions form two completely separated domains. The results may be applied either to the motion of elementary particles in superdense stars or to the motion of celestial bodies in galaxies. (auth)

17018 NOVYE METODY V OBSHCHEI TEORII OTNOSITEL'NOSTI. (New Methods in the General Theory of Relativity). Petrov, A. Z. Moscow, Izdatel'stvo Nauka, 1966. 495p.

An extensive mathematical analysis was made of the theory of gravitation within the limits of the general theory of relativity. New algebraic and differential invariants and Lie group methods were used in the analysis. Problems of gravitational radiation, compensatory fields, behavior of elementary particles in gravitational fields, field interactions, and new aspects of the energy concepts in the gravitational field are discussed. 679 references are included. (R.V.J.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 17296 and 17021.

17019 (UCRL-17282) PHYSICS DIVISION SEMIANNUAL REPORT, MAY-OCTOBER 1966. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Various experiments in high energy research are described. Some cosmic ray research is also included. Theoretical physics is considered including subnuclear, nuclear, and plasma physics. Accelerator operation and development is discussed. (J.F.P.)

Electromagnetic

17020 (CONF-660918-, pp 207-13) COHERENT PAIR PRODUCTION IN THE DIAMOND AS A TOOL TO ANALYSE HIGH ENERGY PHOTON POLARIZATION. Lutz, G.; Schulz, H. D.; Timm, U.; Zimmermann, W. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)).

The method to measure high energy photon polarization with a diamond crystal, which is a logic extension of the coherent bremsstrahlung production applied to pair production $\gamma + N \rightarrow N + e^- + e^+$, is discussed. (B.G.D.)

17021 (ISS-66/35) RELAZIONE SULL'ATTIVITA DELLA SOTTOSEZIONE "SANITA" DELL'INFN NEL 1965-66. (Progress Report on the "Health Subsection" of the INFN for the Period 1965-66). (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 5, 1966. 27p. (In Italian). Dep. mn.

The activities of the "Sottosezione Sanita" of the INFN during the year 1965-66 are discussed. Research work in the fields of elementary particle physics, nuclear physics, solid state physics and electromagnetic interactions is described. A brief account of the activities of the theoretical group and of the Computing Centre is also given. (auth)

17022 (NEVIS-156) THE NEUTRAL DECAYS OF THE η MESON. Grunhaus, Jacob (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Dec. 1966. Contract AT(30-1)-1932. 112p. (CU-1932-260; R-573). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The branching ratios of the neutral decays of the η meson was studied experimentally in the reaction $\pi^- p \rightarrow n\eta$ at incident π^- momentum of 780 ± 8 MeV/c. The distribution of the number of gamma rays attributed to the neutral decays of the η meson was χ^2 fitted to the expected distribution, as obtained using the Monte Carlo technique first assuming three neutral modes ($3\pi^0$, $\pi^0\gamma\gamma$, and $\gamma\gamma$) and then assuming only two neutral modes ($3\pi^0$ and $\gamma\gamma$). The data are more consistent with the existence of three modes $\chi^2 = 0.8$ (a 4° of freedom fit) than with only two modes $\chi^2 = 17.6$ (a 5° of freedom fit). The existence of a substantial rate (comparable to the rates of the other neutral modes) for the decay $\eta \rightarrow \pi^0\pi^0\gamma$ is not consistent with the data. The following results were obtained: $R_1 = [\Gamma(\eta \rightarrow \gamma\gamma)/\Gamma(\eta \rightarrow \text{neutrals})] = 0.44 \pm 0.07$, $R_2 = [\Gamma(\eta \rightarrow \pi^0\gamma\gamma)/\Gamma(\eta \rightarrow \text{neutrals}] = 0.27 \pm 0.10$, and $R_3 = [\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \text{neutrals})] = 0.29 \pm 0.10$. (auth)

17023 SEARCH FOR C NONCONSERVATION IN ELECTRON-POSITRON ANNIHILATION. Mills, Allen P.; Berko, Stephan (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 18: 420-5 (Mar. 13, 1967).

Results of an experiment designed to search for the three-photon decay of $^1S_0$ electron-positron states are reported. The experiment is designed to separate the C-forbidden 3γ decay of $^1S_0$ from the allowed 3γ decay of the $^3S_1$ state by studying the angular distribution of the three photons. Essentially, the 3γ rate at the symmetric configuration and at some other set of angles is measured. (J.F.P.)

17024 PHOTOPRODUCTION OF CHARGED PIONS BY 2- TO 5-GeV TAGGED γ RAYS. Dowd, J. P. (Massachusetts Inst. of Tech., Cambridge); Caldwell, D. O.; Heinloth, K.; Sherwood, T. R. Contract AT(11-1)-34. Phys. Rev. Lett., 18: 414-17(Mar. 13, 1967). (UCSB-34P135-2).

A meson (π) photoproduction experiment in which data could be obtained simultaneously at different unique photon energies was carried out. The vector momenta of the photon incident on the proton and that of the outgoing meson (π) were measured so that the four-momentum transfer of the photon to the meson (π) and the mass of the recoiling baryon system could be determined. Results for the elastic meson (π^+) production are reported and compared with predictions of various models particularly pion exchange altered by final-state absorption or by Reggeization. While no shrinkage is observed, it is possible to obtain a meson (π) trajectory because of the unusually strong Reggeized angular momentum dependence for the reaction $\gamma + p \rightarrow \pi^+ + n$. (J.F.P.)

17025 PHOTOPRODUCTION OF WIDE-ANGLE ELECTRON PAIRS FROM CARBON. Eisenhandler, E.; Feigenbaum, J.; Mistry, N.; Mostek, P.; Rust, D.; Silverman, A.; Sinclair, C.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 18: 425-9(Mar. 13, 1967).

Measurements of the photoproduction of wide-angle electron pairs from carbon in the energy range 600 to 2000 MeV are reported. The results agree with the predictions of quantum electrodynamics substantially better than the previously reported results, based on part of the data presented here, which showed a discrepancy of 2.3 standard deviations. (auth)

17026 CHARGE CONJUGATION IN $\eta \rightarrow \pi^+\pi^-\gamma$. Bowen, R. A. (CERN, Geneva); Cnops, A. M.; Finocchiaro, G.; Mittner, P.; Dufey, J. P.; Gobbi, B.; Pouchon, M. A.; Muller, A. Phys. Lett., 24B: 206-8(Feb. 20, 1967).

A sample of 1620 $\eta \rightarrow \pi^+\pi^-\gamma$ observed in a magnet spark chamber experiment shows no evidence for charge conjugation violation. The result for the asymmetry is A = +1.5% with a statistical error of ±2.5%. (auth)

17027 NEUTRAL DECAYS OF THE η MESON. Kanofsky, Alvin Sheldon. Philadelphia, Univ. of Pennsylvania, 1966. 122p.

Thesis.

Neutral decays of the meson (η) were observed in a spark chamber experiment. The mesons (η) were produced in the reaction $\pi^- + \eta + n$. The beam momentum was set at 780 MeV/c. Events having a neutron time-of-flight falling within the appropriate timing region were classified according to the number of gammas appearing in the spark chambers. The two-gamma to four-gamma plus six-gamma branching ratio obtained was 0.81 ± 0.2. (TSS)

Weak

17028 (UCRL-16168) COMPARISON OF THE POSITIVE AND NEGATIVE MUON DECAY SPECTRA IN COPPER. Beilin, Philip Bert (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 28, 1966. Contract W-7405-eng-48. 114p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Negative muons from the Berkeley 184-in. Synchrocyclotron were stopped in a copper plate target. The momenta of the decay electrons were measured by an Elbek-type wide-gap, broad-range, magnetic spectrometer. Eleven scintillation counters served to define the focal plane for trajectories from the target, through the spectrometer, to the focal plane. For comparison, positive pions were stopped in the copper target giving rise to positive muons upon their decay. The positrons from the subsequent positive muon decay were momentum analyzed under the same experimental conditions as the electrons. The measured positive and negative electron momenta spectra are compared to the theoretical predictions taking into account energy loss straggling and various other experimental resolution effects. Reasonably good agreement was obtained between the positive data and theory. The comparison between the negative decay spectrum and theory seems to be in a less satisfactory state of agreement, the data favoring a faster fall-off with energy at the upper end of the spectrum than theoretically predicted. (auth)

17029 SEARCH FOR DECAY OF NEUTRAL KAONS INTO CHARGED LEPTON PAIRS. Bott-Bodenhausen, M.; De Bouard, X.; Cassel, D. G.; (and others) (CERN, Geneva). Phys. Lett., 24B: 194-8(Feb. 20, 1967).

A search for decays of K_L^0 and K_S^0 into charged lepton pairs is reported. No event was found. Upper limits obtained with 90% confidence for the branching ratios are $\Gamma(K_L^0 \rightarrow \mu^+\mu^-)/\Gamma(K_L^0 \rightarrow \text{all}) < 1.6 \times 10^{-4}$ and $\Gamma(K_S^0 \rightarrow \mu^+\mu^-)/\Gamma(K_S^0 \rightarrow \text{all}) < 7.3 \times 10^{-4}$. (auth)

Strong (Baryon-Induced)

17030 (COO-1195-72) THREE- AND FOUR-BODY STRANGE-PARTICLE FINAL STATES FROM 8 GeV/c p-p INTERACTIONS. Firebaugh, M.; Ascoli, G.; Goldwasser, E. L.; Sard, R. D. (Illinois Univ., Urbana). [1967]. Contract AT-(11-1)-1195. 18p. (CONF-670109-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

Results on the $K^+p\Lambda$ and $\pi K N\Lambda$ final states from p + p interactions in a hydrogen bubble chamber using 8 GeV/c protons are discussed. The invariant mass distributions and four-momentum transfer to the outgoing proton are presented. Also the corresponding phase space predictions for the $K^+p\Lambda$ final state events are shown. One meson exchange predictions are examined. It is concluded that the Y_1^* (1385) and N^* (1236) are present to about the same extent in the $\pi K N\Lambda$ final states of GeV/c. In addition it appears that the Y_1^* (1680) production is increasing in this same region. (J.F.P.)

17031 (COO-1195-78) A STUDY OF THE P P $\pi^+\pi^-$ FINAL STATE IN 8-GeV/c P-P INTERACTIONS. Grether, D.; Ascoli, G.; Firebaugh, M.; Goldwasser, E. L.; Sard, R. D.; Wray, J. (Illinois Univ., Urbana). [1966]. Contract AT(11-1)-1195. 12p. (CONF-670109-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

The preliminary analysis of the four-body final state $pp\pi^+\pi^-$ from p + p interactions at 8 GeV/c is reported. The dominant characteristic of this final state is the strong production of the N^{*++} (1236). This strong production is shown in a Chew–Low plot of the mass of the $p\pi^+$ combination versus the square of the four-momentum transfer to the $p\pi^+$. Invariant mass plots are also shown. (J.F.P.)

17032 (COO-1195-86) STRANGE-PARTICLE PRODUCTION IN 8 BeV/c PROTON–PROTON INTERACTIONS. Firebaugh, Morris William (Illinois Univ., Urbana. Dept. of Physics). May 1966. Contract AT(11-1)-1195. 200p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

An experiment was performed in which 37,000 pictures were obtained of the hydrogen bubble chamber exposed to 8 BeV/c protons. All 2, 4, 6, and 8 prong events with one or more associated kinks or V's were scanned for and 7,300 candidates for strange particle events were found. Of these, 3,600 were successfully measured and, of these, 1,260 strange particle events were identified. A fiducial region was selected and the partial cross section for 33 different final states calculated. This corresponds to a corrected cross section for identified strange particle events of 950 ± 95 μb. The total strange particle production cross section is estimated to be 1.8 mb. Evidence for N^*(1236), Y_1^*(1385), Y_0^*(1405), and Y_1^*(1660) formation is presented. Data concerning the existence of reported di-baryon resonances in the ΛN final state are presented, and the conclusion is drawn that no such resonances appear in the ΛN and ΣN mass distributions of this experiment. Finally, the 3 body final states are examined in detail. An anomalous peaking is observed in the $K^+\Lambda$ invariant mass in the $K^+p\Lambda$ final state. The simple one pion exchange model does not seem to predict adequately the distribution observed. The OPEM also predicts a cross section for this final state a factor of 2 larger than the measured value of 54 ± 7 μb if no cutoff in 4-momentum transfer to the proton is imposed. (auth)

17033 (JINR-P1-3146) POISKI NUKLONNOI IZOBARY S T = 5/2 V np-VZAIMODEISTVIYAKH. (The Search for the Nucleon' Isobar With T = 5/2 in np-Interactions). Vishnevskii, V. F.; Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 6p. (In Russian). Dep. mn.

The distributions are given on effective masses of $p\pi^+\pi^+$ and $n\pi^-\pi^-$ combinations for 114 cases of $np \rightarrow pn\pi^+\pi^+\pi^-\pi^-$ and $np \rightarrow pn\pi^+\pi^+\pi^-\pi^-\pi^0$ reactions produced by bombarding a 24-liter propane bubble chamber with 2-10 GeV neutrons. In these distributions the enhancements are pointed out in the mass region from 1600 up to 1170 MeV/c^2 which differ from background curves by three standard deviations. (auth)

17034 (NEVIS-157) THE ANNIHILATION OF STOPPING ANTIPROTONS INTO K MESONS. Barash, Naomi (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Jan. 1967. Contract AT(30-1)-1932. 101p. (CU-1932-261; R-575). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

This study of the annihilation of antiprotons into K mesons is based on a sample of about 700,000 antiprotons which were stopped in the 30-in. Columbia-BNL liquid hydrogen bubble chamber. Branching ratios into the various final states containing K mesons were measured, and production of the K^*, ω, and η resonances was studied. The quantum numbers of some of the final states were determined, making use of symmetry arguments. Predictions of various unitary symmetry schemes are also discussed, and are compared with experimental results. (auth)

17035 INVESTIGATIONS OF DIFFRACTION GENERATION OF π MESONS BY PROTONS WITH AN ENERGY OF 20 GeV. Boos, E. G.; Takibaev, Zh. S.; Tursunov, R. A. (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Dokl. Akad. Nauk SSSR, 170: 1041-3(Oct. 11, 1966). (In Russian).

Coherent generation of π-mesons in three-ray events arising in an Ilford G-5 emulsion under the action of protons with an impulse of 1918 GeV/s was subjected to further study (cf. E. G. Boos, N. P. Pavlova, and R. A. Tursunov, Preprint P-2623, Joint Institute of Nuclear Research, Dubna, 1966). Secondary particles in 179 three-ray interactions over a length of 2927 m were identified. The distribution of the events with respect to angular criteria δ was determined. The distribution of 30 events with $\delta < 0.6$ with respect to the square of the four-dimensional impulse q^2 was 0.14 0.14 ± 0.03 (GeV/s)^2 for the 30 events and 0.15 ± 0.04 (GeV/s)^2 for 13 events among them for which reliable identification of the secondary particles was made. The distribution with respect to the transverse impulse $P_\perp$ carried away by the $(p\pi\pi)$ system was determined. The average value of $P_\perp$ was 0.18 ± 0.03 GeV/s (0.17 ± 0.05 GeV/s for 13 events), which was considerably smaller than the value of 0.30 ± 0.03 GeV/s found for three-ray pn interactions. Determination of the distribution of the three-particle system with respect to the effective mass M indicated that the average value of M was 1.61 ± 0.30 GeV for all events and 1.63 ± 0.45 for 13 events. The statistical reliability of the data obtained was insufficient to permit a definite conclusion as to whether the formation of π-mesons was of the resonance type. (CFSTI)

17036 ASYMMETRY IN THE EMISSION OF π^+ MESONS IN 612 MeV pp-COLLISIONS WITH A POLARIZED PROTON BEAM. Borisov, A. A.; Kuznetsov, A. S.; Lukashov, V. E.; Nurushev, S. B.; Solov'yanov, V. L. Yadern. Fiz., 5: 348-53(Feb. 1967). (In Russian).

Experiments are described determining the azimuthal asymmetry in the production of π^+-mesons in proton-proton collisions, using a 612 MeV polarized proton beam. The measurements were performed in the region of l.s. angles 85 to 125° using a scintillation hodoscopical device. For fixed angles the asymmetry was determined for three values of the π^+-meson emission energy. The experimental results are compared with the predictions of the one-meson approximation model. (auth)

17037 MEASUREMENT OF THE TRIPLE SCATTERING PARAMETER R_{pn} AT 70° CMS AND THE PHASE SHIFT ANALYSIS AT 630 MeV. Kazarinov, Yu. M.; Legar, F.; Pisarev, A. F.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 140-5(Jan. 1967). (In Russian).

The parameter R_{pn} and the polarization in the elastic 605-MeV pn scattering were measured at 70°, with the result $R_{pn} = 0.09 \pm 0.19$ and $P_{pn} = -0.05 \pm 0.18$. These data were used to perform a phase shift analysis at 630 MeV, to calculate the experimentally measurable quantities and to plan further experiments, determining the parameters D_{pn}, R_{pn}, A_{pn}, C_{np}^{pn} and A_{np}^{pn}. The planning showed, that within the given experimental possibilities, a measurement of the parameters D_{pn} and A_{pn} will be the most efficient way to discriminate between the two remaining sets of phase shifts. (auth)

17038 SPIN CORRELATION IN THE ELASTIC SCATTERING OF POLARIZED 605 MeV PROTONS ON PROTONS. Golovin, B. M.; Zulkarneev, R. Ya.; Kiselev, V. S.; Medved, S. V.; Nikanorov, V. I.; Pisarev, A. F.; Semashko, G. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 146-9 (Jan. 1967). (In Russian).

The spin correlation coefficients in the elastic pp-scattering were measured at 90° cms, using a polarized 605 MeV proton beam. Spark chambers controlled by scintillation counters were used in the measurements. The following values of the coefficients were determined: $C_{nn} = 0.56 \pm 0.18$, $C_{KP} = 0.27 \pm 0.18$, $C_{qKn} = 0.92 \pm 0.38$. (auth)

17039 NEUTRON–PROTON SMALL ANGLE SCATTERING AT 14.1 MeV. Suhami, A.; Fox, R. (Technion-Israel Inst. of Tech., Haifa). Phys. Lett., 24B: 173-4(Feb. 20, 1967).

The neutron-proton differential cross section was measured at an energy of 14.1 MeV for angles between 12 and 90° c.m. A least-squares fit of the data to a straight line has a slope of 2 ± 4% between the measured angles. This slope is in agreement with the predicted isotropy as calculated by Nakamura from the theory of Hamada and Iwadare. (auth)

17040 INTERFERENCE OF pp NUCLEAR AND COULOMB SCATTERING AMPLITUDES AT 6 GeV. Markov, P. K.; Chernev, Kh. M. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 39-50(1966). (In Russian).

A thin target of about 1 μm thickness was exposed to a 6 GeV proton beam. The experimental arrangement is shown. Five photoemulsion stacks A, B, C, D, and E recorded the secondary parti-

cles emitted in the angular region 75–88° in lab system. A total of 33,645 recoil protons were registered. The differential cross sections at 18 angles were determined in absolute units using a monitoring system. They were analyzed by the Bethe formulas, taking into account the radiation corrections after Soloviev. The ratio of the real to the imaginary part of the elastic pp forward scattering amplitude proved to be a = −0.39 ± 0.08. (auth)

Strong (Meson-Induced)

17041 (COO-1195-79) PRODUCTION OF Ω^- HYPERONS IN K^-p INTERACTIONS AT 5.5 BeV/c. Schultz, P. F.; Ascoli, G.; O'Halloran, T. (Illinois Univ., Urbana); Dagan, S.; Simpson, J. D.; Kropac, W. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Hartung, R.; Krauss, R.; Reeder, D. (Wisconsin Univ., Madison). Feb. 15, 1967. Contract AT(11-1)-1195. 17p. (CONF-670109-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

Hyperon (Ω^-) events were found in 400,000 pictures of $K^- + p$ interactions in a hydrogen bubble chamber. The beam momentum was 5.5 GeV/c. The mass, decays, and lifetimes of the hyperon (Ω^-) are studied. (J.F.P.)

17042 (COO-1195-80) $\Sigma^+\pi^-$ AND $\Sigma^+\pi^+\pi^+\pi^-$ FINAL STATES IN K^-p INTERACTIONS AT 4.1 AND 5.5 GeV/c. Loos, J. S.; Goldwasser, E. L.; Kruse, U. E. (Illinois Univ., Urbana). Feb. 6, 1967. Contract AT(11-1)-1195. 18p. (CONF-670109-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

$K^- + p$ exposures at 4.1 and 5.5 GeV/c were taken from which preliminary results on the study of the $\Sigma^+\pi^-$ and $\Sigma^+\pi^+\pi^+\pi^-$ final states produced are reported. The report is based on data from all of the 4.1-GeV/c film and from about 40% of the 5.5 GeV/c film. Highly peripheral production is observed in the process $K^- + p \rightarrow \Sigma^+ + \pi^-$ at both 4.1 and 5.5 GeV/c. It is also observed that the process $K^- + p \rightarrow \Sigma^+ + \pi^+ + \pi^+ + \pi^-$ is dominated by the 3-body final states: $Y^{*+}\pi^+\pi^-$ and $\Sigma^+\pi^+$ plus neutral meson. No evidence is found for new Y^* resonance production. (J.F.P.)

17043 (JINR-E1-3100) STUDY OF NEUTRAL BOSONS DECAYING INTO π^0 MESONS AND γ QUANTA. Strugalski, Z. S.; Chuvilo, I. V.; Ivanovskaja, I. A.; Okhrimenko, L. S.; Niczyporuk, B.; Kanarek, T.; Jablonski, Z.; Slowinski, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 32p. Dep. mn.

The production and decays of neutral bosons into π^0 mesons and γ quanta are searched in film obtained in an exposure of a 23-inch xenon bubble chamber. The distribution of the effective masses $m_{\gamma\gamma}$, $m_{\pi^0\pi^0}$, $m_{\pi^0\gamma\gamma}$ of, $\gamma\gamma$, $\pi^0\pi^0$, and $\pi^0\gamma\gamma$ are presented and analyzed. (auth)

17044 (UCRL-17152) MEASUREMENT OF THE Σ^- POLARIZATION IN THE PROCESS $\pi^- + p \rightarrow \Sigma^- + K^+$. Weldon, David Michael (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1967. Contract W-7405-eng-48. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The average polarization of the Σ^- produced in the reaction $\pi^- + p \rightarrow \Sigma^- + K^+$ was measured between center-of-mass angles 134 and and 166° for an incident π^- momentum of 1145 MeV/c. A polarized proton target was used and the Σ^- polarization was found by measuring the difference in the production-rate of K^+ mesons for protons polarized along the production-plane normal and against it. Spark chambers were used to record the π^- and K^+ trajectories, and the π^- momentum was obtained from a magnetic spectrometer while the K^+ momentum was obtained from a range telescope. Each event was kinematically reconstructed in a one constraint fit to help eliminate events produced from protons bound in heavy nuclei of the target. The Σ^- polarization was found to be −0.36 ± 0.46. (auth)

17045 (UCRL-17263) MEASUREMENT OF THE POLARIZATION PARAMETER IN THE ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS FROM 600 TO 3300 MeV/c. Hansroul, Michel (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The polarization parameter in π^-p elastic scattering was measured at eleven incident-pion momenta ranging from 0.6 to 3.3 GeV/c. The negative pion beam was focused on a polarized proton target and the scattered pion and recoil protons were detected in coincidence by counter hodoscopes. The polarization parameter was obtained from a measurement of the difference in counting rates for the target protons' spins parallel and antiparallel to the normal to the scattering plane. An on-line PDP-5 computer was used in the data encoding and transferred the information onto magnetic tape for later computer analysis. The results serve to fill in some gaps in previous experiments. An attempt to fit the new data and previously available data by means of a phase-shift analysis for energies below 1050 MeV was successful in finding good fits to the data but was unsuccessful in that no unique solution was demonstrated. (auth)

17046 COHERENT PRODUCTION OF π-MESONS IN COLLISIONS OF 3.85 GeV/c π^--MESONS WITH PHOTOEMULSION NUCLEI. Shahbazian, B. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B1: 16-20(1967).

The upper limit of the cross section of the coherent production process $\pi \rightarrow 3\pi$ on emulsion light nuclei is found to be 0.5 mb, if the existing selection criteria for the corresponding events are used. (auth)

17047 THE NEUTRON-NEUTRON SCATTERING LENGTH FROM THE REACTION $n + d \rightarrow 2n + p$. Bar-Avraham, E.; Fox, R.; Porath, Y.; Adam, G.; Frieder, G. (Israel Inst. of Tech., Haifa). Nucl. Phys., B1: 49-56(1967).

In order to examine the source of discrepancy in determining the neutron-neutron scattering length a_{nn} from the reactions $\pi^- + d \rightarrow 2n + \gamma$, and $n + d \rightarrow 2n + p$, the latter reaction was performed using higher energy resolution and statistics. The results of the experiment were analyzed, using the impulse approximation. The a_{nn} value was found to be −14 ± 3 fm, which is in agreement with the $\pi^- + d \rightarrow 2n + \gamma$ results. (auth)

17048 OBSERVATION OF THE $\Lambda\eta^0$ RESONANCE IN π^-p INTERACTIONS AT 4.0 GeV/c. Bubelev, E. G. (Joint Inst. for Nuclear Research, Dubna, USSR); Chadraa, B.; Chuvilo, I. V.; (and others). Phys. Lett., 24B: 246-9(Mar. 6, 1967).

The radiative decays of resonances with Λ^0 hyperons involved were studied in the 24-liter propane bubble chamber exposed to 4.0 GeV/c negative pions. The $M_{\Lambda\gamma}$ effective mass distribution exhibits a peak which can be explained by the existence of the $\Lambda\eta^0$-resonance with mass of about 1680 MeV. The kinematic influence of the known hyperon resonances on the distributions is discussed. An attempt is being made to determine the $\Lambda\eta^0$ spin. (auth)

17049 STUDY OF RESONANCES IN $\pi^0\gamma$ SYSTEM. Barmin, V. V.; Dolgolenko, A. G.; Meshkovskii, A. G.; Shebanov, V. A. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 24B: 249-52(Mar. 6, 1967).

By studying events of the type $\pi^- + p \rightarrow n + 3\gamma$, evidence is obtained for a meson of mass 1300 MeV which has a $\pi^0\gamma$ decay mode. (auth)

17050 STUDY OF THE REACTION $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ at 2.36 GeV/c. Huwe, D.; Marquit, E.; Oppenheimer, F.; Schultz, W.; Wilson, J. R. (Univ. of Colorado, Boulder). Phys. Lett., 24B: 252-6(Mar. 6, 1967).

Data are presented on the production of ρ^0 by 2.36 GeV/c π^- in hydrogen. Density matrix elements are calculated and evidence concerning an S-wave resonance is discussed. Data on the production of N^{*-} are included, and 1700 ρ^0 are analyzed. (auth)

17051 INVESTIGATION OF π^--MESON INTERACTIONS WITH Xe NUCLEI AT 5 AND 9 GeV/c BY A STUDY OF THE CHARACTERISTICS OF THE PRODUCED π^0 MESONS. Daskiewicz, M.; Slowinski, B.; Strugalski, Z. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 341-7(Feb. 1967). (In Russian).

The energetic, angular and multiplicity characteristics of γ quanta produced in the interactions of 5 and 9 GeV/c π^--mesons with Xe nuclei, were investigated. An analysis points to the predominant role of quasi-elementary interactions in the considered process, with few (≤4) secondary charged particles. (auth)

17052 ESTIMATION OF THE NUCLEAR BACKGROUND IN THE STUDY OF π^-p INTERACTIONS IN HEAVY LIQUID BUBBLE CHAMBER. Elenskii, Ya. S.; Shebanov, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 330-6(Feb. 1967). (In Russian).

Relations between reactions on free hydrogen (n_1) and on bound protons without nuclear breakup (n_2), were obtained in a study of 2.8 GeV/c π^--meson interactions in a propane-xenon bubble chamber. A difference method was used to determine the ratio of nuclear events in various reactions $\alpha_{b.c.} = n_2/(n_1 + n_2)$. If no kinematical criteria were used to select hydrogen reactions the nuclear background ($\alpha_{b.c.}$) is between 37 and 62% for various types of reactions. Further the data obtained using the bubble chamber were used to estimate the values $\alpha_{s.c.}$ for possible experiments with spark chambers, in which the electrodes contain free hydrogen. It is shown that for thin electrodes (<0.2 g/cm^2) $\alpha_{s.c.}$ is close to $\alpha_{b.c.}$. (auth)

17053 DOUBLE CHARGE EXCHANGE OF 50- TO 176-MeV π^- MESONS IN PHOTOEMULSION. Batusov, Yu. A.; Bunyatov,

S. A.; Sidorov, V. M.; Yarba, V. A.; Ionice, G.; Losnianu, E.; Mihul, V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 354-6(Feb. 1967). (In Russian).

The total double charge-exchange cross sections for π^--mesons on photoemulsion nuclei were measured for eight energy values in the region 50 to 176 MeV. (auth)

17054 MESON + HYPERON FINAL STATES IN K^-p INTERACTIONS AT 4.1 AND 5.5 GeV/c. Mott, J. (Northwestern Univ., Evanston, Ill.); Ammar, R.; Davis, R. E. P.; Kropac, W.; Schweingruber, F.; Derrick, M.; Fields, T.; Hyman, L. G.; Loken, J.; Simpson, J. Phys. Rev. Lett., 18: 355-19(Mar. 6, 1967).

Differential cross sections for reactions of the type $K^- + p \rightarrow$ neutral hyperon + neutral meson were measured. The cross sections for peripheral production of vector mesons satisfy certain relations yielded by the independent quark model and other symmetry schemes. The cross section for meson production in the backward hemisphere provides some information on the presence of various baryon-exchange processes. (auth)

17055 CONTRIBUTION TO THE DETERMINATION OF THE SPIN AND PARITY OF $Y_1^*(1385)$ RESONANCES AND EXPERIMENTAL STUDY OF THE PERIPHERAL PRODUCTION IN THE REACTIONS $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$ WITH 1.5-GeV/c BEAMS. Fridman, Alfred (Univ., Strasbourg). Ann. Phys. (Paris), 1: 577-612(Sept.-Oct. 1966). (In French).

The spin and parity of the $Y_1^*(1385)$ resonances was studied by interaction of a K^- beam with a liquid H_2 target contained in a track chamber. The analysis of the spin and parity is based on the study of the angular distribution of the resonance decay and on the measurement of the polarization of the decay Λ. The peripheral production in all channels having $\Lambda\ \pi^+\pi^-$ in the final state was also studied. The experimental problems in the identification of the events having the $\Lambda\ \pi^+\pi^-$ particles in the final state were discussed. The experimental results show that the $Y_1^*(1385)$ resonances are not obtained by peripheral production. This is not surprising since the energy in the center of mass is relatively low and there is consequently only an energy of 335 MeV/c^2 available to furnish the kinetic energy to the final reaction product. On the contrary in the resonant channel $K^- + p \rightarrow \Lambda + \pi^- + \pi^+$ there is a relatively important contribution of events produced peripherally. On the basis of the Yang and Treiman distribution it was shown that the predominant part of the peripheral production occurs by exchange of a vector boson with K^*. (J.S.R.)

17056 RESONANCES AND OTHER PARTIAL WAVES IN $K^-p \rightarrow \Sigma\ \pi$ BETWEEN 780 AND 1220 MeV/c. Armenteros, R. (CERN Geneva); Ferro-Luzzi, M.; Leith, D. W. G.; (and others). Phys. Lett., 24B: 198-203(Feb. 20, 1967).

A partial wave analysis of the reaction $K^-p \rightarrow \Sigma^+\pi^-$ and $\Sigma^-\pi^+$ is presented. Results are given on resonance formation in the mass region from ~1.7 to ~1.9 GeV. (auth)

17057 STRUCTURE IN π^+p ELASTIC BACKWARD SCATTERING. Dobrowolski, T.; Gus'kov, B. N.; Likhachev, M. F.; Lubimov, A. L.; Matulenko, Yu. A.; Stavinskii, V. S.; Vovenko, A. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 203-6(Feb. 20, 1967).

The energy dependence of the differential cross section for π^+p elastic scattering at a cm angle near 174° was measured. The momentum range of incident π^+ was 2.06-4.70 GeV/c. On this energy dependence one can see a structure, i.e., maxima corresponding to the baryon resonances Δ (2420) and Δ (2840). The structure is used for determination of the parities of these resonances. (auth)

17058 STUDY OF THE REACTION $\pi^- + p \rightarrow \pi^+ + \pi^- + n$ AT 2.36 GeV/c. Huwe, D.; Marquit, E.; Oppenheimer, F.; Schultz, W.; Wilson, J. R. (Univ. of Colorado, Boulder). 12p. (CONF-660107-65). DTIE. Gmelin, AED-CONF-66-003-158.

From American Physical Society Meeting, New York.

Two-prong events were analyzed from an exposure of the Alvarez 72-in. hydrogen bubble chamber to 2.36-GeV/c negative pions to study the final state $\pi^- + p \rightarrow \pi^+ + \pi^- + n$. In ~24,000 pictures 4,039 events satisfying the reaction with a χ^2 probability >0.01 were obtained. Analysis of the $\pi^+\pi^-$ effective mass ($M_{\pi^+\pi^-}$) distribution and the $n\pi^-$ effective mass distribution are presented. (B.G.D.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 17395.

17059 MASS VARIATION OF A COMPOSITE PARTICLE VERSUS THAT OF ITS CONSTITUENT. Hirayama, Minoru (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1219-25 (Dec. 1966).

Relations between the mass of a composite particle and masses of constituents are investigated. The property that the former varies more slowly than the latter is found in some limited models. It is also shown that the mass of a composite particle, in some cases, becomes smaller as the mass of a constituent becomes larger. (auth)

17060 ON G-PARITY DOUBLET BOSONS. Inoue, Takeshi (Kyoto Univ.); Nakazawa, Kazo; Sugano, Reiji. Progr. Theoret. Phys. (Kyoto), 36: 1226-42(Dec. 1966).

G-parity doublet bosons are investigated, which consist of the ordinary boson and the abnormal boson with opposite G parity to the ordinary one. It is shown that the G-parity doublet bosons appear in higher configurations of all models. The Yukawa and the electro-magnetic interactions for the abnormal boson are discussed. In particular, by consideration analogous to Lee's and the principle of the minimal electromagnetic interaction, the possibility of constructing the C-nonconserved electromagnetic interaction for the G-parity doublet bosons with spin 1 is proved. Finally, the production and decay of the abnormal boson are analyzed. (auth)

17061 PHYSICS IN THE LAST TWENTY YEARS. Segre, Emilio (Univ. of California, Berkeley). Naturwiss. Rundsch., 19: 357-60(Sept. 1966). (In German).

Developments in the following fields are reviewed: nonconservation of parity, particle physics, low-energy nuclear physics, solid state physics, atomic physics, and computer technology. It is suggested that in the last 20 yr, from the fundamental point of view, the outstanding discovery has been the nonconservation of parity in weak interactions. This and development of quantum electrodynamics are the only postwar discoveries that have added new knowledge to the foundations of physics. The discovery of the nonconservation of parity seems to show an intrinsic asymmetry in space, or, in space and time, to particle-antiparticle symmetry. In the experimental field the outstanding progress has been in the physics of particles. The study and classification of these particles has led to the assignment of mass charge, lifetime spin, parity, and other quantum numbers to many particles. The concept of strangeness has aided in the classification of these particles. The concept of isotopic spin, introduced in connection with nuclear physics, has acquired great importance. The relative number of physicists engaged in various areas of physics research is estimated. (BBB)

17062 SPIN OF A PARTICLE. Metzger, Pierre (Ecole Polytechnique, Paris). Commun. Math. Phys., 4: 177-89(1967). (In French).

The spin of a free relativistic particle is studied using the language defined by Laurent Schwartz. In contradistinction with what has been done often, the work is done completely in the Hilbert space of the particle, without using (improper) pure states of energy-momentum. The formalism is explained in a general basis-independent way and then the whole calculus is performed on a particular example. The probabilities of spin orientation along a quantization axis depend on the observer. (auth)

17063 GLOBAL AND DEMOCRATIC METHODS FOR CLASSIFYING N-PARTICLE STATES. Levy-Leblond, Jean-Marc (Univ. of Rochester, N. Y.). J. Math. Phys. (N. Y.), 7: 2217-29 (Dec. 1966). (UR-875-136).

The "global method" for describing N-particle systems (which relies on the existence of a large invariance group of the total Hamiltonian for N noninteracting particles, the "great group", whose Lie algebra is generated by the "grand angular momentum tensor"), is adapted to describe systems of identical particles by means of basis states with simple symmetry properties (with respect to permutations of the particles). The concept of "democracy" among the particles is defined and studied, from which the "democratic" subgroups of the great group are obtained. The eigenvectors of a complete set of commuting observables, consisting essentially of Casimir operators of democratic subgroups, may furnish the desired basis. Unfortunately the scheme is seen to be sufficient only in the 3- and 4-particle cases, which, however, are most important. The Appendix contains a discussion of the possible relativistic generalizations of the global method. (auth)

17064 GENERALIZED FUNCTIONS AND DISPERSION RELATIONS IN PHYSICS. Guettinger, W. (Univ., Munich). Fortschr. Phys., 14: 483-602(1966).

Recent development of the theory of generalized functions and their applications to dispersion relations, system theory, and elementary particle physics are presented in a coherent and self-contained fashion. Topics discussed are a definition and opera-

tions with generalized functions, transformation of variables, Fourier transforms of generalized functions, singular positive and positive-definite generalized functions, dispersion relations and boundary values of analytic functions. Differential equations of physics, the passive system of S-matrix theory, Lorentz invariant generalized functions, rigged Hilbert spaces, and problems of quantum field theory and S-matrix theory are also discussed. (J.F.P.)

17065 TREIMAN–YANG TEST AND TRIANGULAR GRAPHS. Kolybasov, V. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 288-94(Feb. 1967). (In Russian).

It is considered, on the example of simple nonrelativistic triangular graphs whether the Treiman–Yang test can be satisfied, if the main contribution to the amplitude of the reaction A + x → B + y + z is not due to the pole graph, but to more complicated ones. Specific situations in which this is the case are shown. An investigation of this problem is important for understanding how reliably the fulfilment of the Treiman–Yang test indicates the pole character of the reaction. (auth)

17066 DIRAC EQUATIONS IN LATTICE SPACE AS AN EXAMPLE OF ELEMENTARY PROCESSES FOLLOWING THE THEORY. Bopp, Fritz (Univ., Munich). Z. Phys., 200: 117-32(1967). (In German).

The quantum theory of particles in a lattice space with a finite number of points is considered. Assuming a simple cube translation lattice, the Hamiltonian (Schrödingerian) for free motions is defined by the following conditions: the Hamiltonian for free motions is a bilinear Hermitean form of $\psi\uparrow,\psi$, the number of pairs of operators $\psi^{\dagger}_{\nu},\psi_{\nu}$ in each lattice point is as small as compatible with the other conditions, the Hamiltonian is, of course, homogeneous, in one step there are only motions from any point to its next neighbors, the Hamiltonian is invariant against all the symmetry operations of the lattice. By these conditions the Hamiltonian is uniquely defined and leads to the following spectrum of the eigenvalues: $E = \pm\sqrt{k^2 + m^2}$, $k = (k_1,k_2,k_3)$, $k_l = 2\Omega\sin(2\pi h_l/Z)$. Ω and m are parameters, $h = (h_1,h_2,h_3)$ are the Miller indices, which form a vector in the reciprocal lattice, Z is the number of lattice points along an edge. In the limit $Z \to \infty$ the last expression turns over to the relastivistic relation between energy and momentum $E = \pm c\sqrt{p^2 + m^2c^2}$. Therefore a quasirelativistic Hamiltonian for free motions in a lattice space can be considered. Hole theory and particle-antiparticle relation are the same as in the Dirac theory. They are connected by well defined and explicitly given transformations. (auth)

17067 QUASIRELATIVISTIC URFERMIONS. Bopp, Fritz (Univ., Munich). Z. Phys., 200: 133-41(1967). (In German).

The quantum theory of fermions in a lattice space with a finite number of points, say Z^3 was previously reformulated. Of course, Lorentz invariance holds only in the limit $Z \to \infty$. So far a lattice space with Z^3 points provides only a convenient method to define the order of some limiting processes. A more fundamental question is discussed. According to general relativity Lorentz invariance can not hold all over the world and must also be broken at tiny distances of the centers of particles. If the space curvature is not essential for the theory of elementary particles, as generally is assumed, the topological structure of the deviations from Lorentz invariance only must be taken into account. In this respect the lattice space provides a rather rough but sufficient picture of a space, being approximately Lorentz invariant only for intermediate distances. In a lattice with Z^3 points the Hilbert space has a finite number of dimensions. It seems important that this assumption will hold, even if a more refined space model is derived. (auth)

17068 MUTUAL EXCHANGE IN LATTICE SPACE. Bopp, Fritz (Univ., Munich). Z. Phys., 200: 142-57(1967). (In German).

The Dirac equation in a lattice space with a finite number Z^3 of points was developed previously. This equation is quasi relativistic. For in the limit $Z \to \infty$ the relativistic energy-momentum relation is obtained. The quasi relativistic interaction operator from a lattice space is derived. First it is proven that, without any loss of generality, the number of particles can be assumed as constant. Then an interaction operator being uniquely defined by some postulates, the most important of which are the particle-hole symmetry (either the particles or the antiparticles may be considered as holes), the Racah covariance (eigenvalues are symmetrical to zero), the Touschek covariance (eigenvalues depend only on the square of the bare mass κ) is deduced. The other postulates are more or less obvious: 2-particle-forces, local interaction, translation invariance and cube symmetry. In the limit $Z \to \infty$ the operator is Lorentz invariant. Since the parity symmetry is broken, some alternative systems of postulates are considered. Finally it is pointed out that the proper elementary particles are quasi particles in a certain Dirac sea of a constant number of urfermions. Essentially as in Dirac's original theory of free particles the urfermions occupy half of the quantum places of the lattice. Of course, the Dirac sea now is modified by an interaction. (auth)

17069 QUANTUM MECHANICAL CALCULATION OF THE COLLISION TIME. Baz, A. I. Yadern. Fiz., 5: 229-35(Jan. 1967). (In Russian).

The time period T, during which colliding particles with the energy E are at a distance smaller than R, is calculated using quantum mechanics. The only restriction on the radius R is that it should be larger, than the radius of the interaction between the particles. It is shown that for a given energy the time T for single-channel systems has a fixed value. In other words, the distribution w(T), with respect to the life times of intermediate states, produced in the collision, can be written as $w(T) = \delta T(T - \overline{T})$. (auth)

17070 DISPERSION RELATIONS IN THE ONE-BOSON LEE MODEL. Scarfone, Leonard; Brooks, G. Lantry Jr. (Univ. of Vermont, Burlington). Amer. J. Phys., 35: 104-10(Feb. 1967).

The one-boson Lee model is used as a simple example for demonstrating how the methods of dispersion theory can be used to calculate state vectors, wavefunction renormalization constants, and self-energies without having to solve eigenvalue equations. This method of solution was applied successfully to the original Lee model; some analogous calculations at a more elementary level are given. The same point of view was taken previously where the Lehmann–Symanzik–Zimmermann formalism was used to solve the first nontrivial sector of the one-boson case. (auth)

17071 REGGE POLE AND SINGLE PARTICLE EXCHANGE MECHANISMS IN HIGH ENERGY COLLISIONS. Van Hove, L. (CERN, Geneva). Phys. Lett., 24B: 183-4(Feb. 20, 1967).

It is shown that if particles and resonances occur in infinite Regge recurrence series, the well-known contradiction between Regge pole and single particle exchange models for high-energy two-body collisions can be avoided, and double particle exchange is depressed with respect to single exchange. (auth)

Electromagnetic

Refer also to abstract 17112.

17072 (ISS-66/49) A SOFT PHOTON EMISSION APPROACH TO $\pi^0 \to \gamma\gamma$ AND $\eta \to \gamma\gamma\pi^0$ DECAYS. Maiani, L.; Preparata, G.. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Dec. 14, 1966. 12p. Dep. mn.

The partial conservation of the tensor current (PCTC) and the local U(12) commutation rules are used to treat processes in which soft photons are emitted. Two applications are given concerning the $\pi^0 \to \gamma\gamma$ and $\eta \to \gamma\gamma$ decays and the branching ratio $(\eta \to \pi^0\gamma\gamma)/(\eta \to \gamma\gamma)$. The results are found to be in remarkable agreement with the experiments. (auth)

17073 ALGEBRA OF CURRENTS AND THE MESON FORM FACTORS. Cocho, G. (IAEA, Trieste, Italy); Harun-ar-Rashid. Progr. Theoret. Phys. (Kyoto), 36: 1150-3(Dec. 1966).

The equal-time commutation relation for the electromagnetic current is used to derive a sum rule for the pion form factor following the covariant method of Fubini. It is shown that the inclusion of pion, ω-meson and A_1-meson (1^+) intermediate states gives a charge radius of the pion in agreement with the recent experimental data. (auth)

17074 ELECTROMAGNETIC PROPERTIES OF BARYONS AND THE QUARK MODEL. Ishida, Shin (Nihon Univ., Tokyo); Konno, Kimiaki; Shimodaira, Hajime. Progr. Theoret. Phys. (Kyoto), 36: 1243-65(Dec. 1966).

The electromagnetic properties of baryons are investigated from the viewpoint of the Sakata Model, in which quarks are chosen as the three fundamental particles. Since vector mesons couple to the baryon indirectly through the constituent quarks, the electromagnetic form factor of the baryon has a further contribution coming from the baryon wave function as well as contributions from ρ, ω, and φ. This permits avoidance of the difficulty encountered in the usual vector meson model in fitting the data with only the known ρ, ω, and φ. It is also shown that in the "nonet limit" only ρ and ω contribute to the nucleon form factors. This explains the experimental relations $G_p^E \approx G_p^M/\mu_p \approx G_n^M/\mu_n$ and $G_n^E \approx 0$. The form factors of the other baryons are also derived. Furthermore, knowledge of the form factors is applied to estimate the electromagnetic mass differences between baryons. According to this analysis it is predicted that the nucleon form factors will continue to maintain a value appreciably different from zero up to a fairly large value of k^2. Sum rules and inequalities among the mass differences are derived in the model with SU(3) breaking effects included. (auth)

17075 THE DIRAC EQUATION AT HIGH ENERGIES. Majumdar, S. Datta (Indian Inst. of Tech., Kharagpur). Nucl. Phys., B1: 41-8(1967).

It is shown that the wave function for a high-energy electron scattered by a central field (such as the electrostatic field of spherical nuclei) can be obtained by solving a "Schrödinger equation" with a complex potential energy. This is found to be true for a general central field if the rest mass of the electron can be neglected in comparison with its kinetic energy. The restriction can be removed in the case of a pure Coulomb field and an exact equation, valid for all energies, can be obtained. This permits bound states in a Coulomb field to be treated on the same footing as scattering states. The present formulation is expected to simplify phase-shift calculations and to facilitate solution by other means. (auth)

17076 ON THE REGGE POLE MODEL FOR ISOVECTOR NUCLEON FORM FACTORS. Meng, Ta-chung (Technische Hochschule, Karlsruhe, Ger.). Nucl. Phys., B1: 219-24(1967).

A modified Regge-pole model for isovector nucleon form factors is proposed and applied to the calculation of the parameters introduced by Desai and by Höhler et al. (auth)

17077 ON THE PRODUCTION OF ISOBARS IN A CURRENT ALGEBRA APPROACH. Angelescu, N.; Radescu, E. (Inst. for Atomic Physics, Bucharest). Nucl. Phys., B1: 196-8(1967).

Relations between off-mass-shell amplitudes for reactions of the type: γ (real or virtual) + proton → baryon resonance + vector meson are derived on the basis of the partial-conserved tensor current hypothesis. An off-mass-shell gauge condition for the amplitudes of these processes is established. (auth)

17078 PHOTOPRODUCTION OF VECTOR MESONS FROM NUCLEONS. Harun-ar-Rashid (IAEA, Trieste, Italy). Nucl. Phys., 87: 306-20(1966).

The photoproduction of ρ- and ω-mesons from nucleons is treated phenomenologically, emphasizing the suitability of choosing a particular set of 12 invariant amplitudes of this process. These are obtained in analogy with Compton scattering from nucleons so that the expressions for the physical observables are closely related in the two cases. Contributions to the amplitudes from nucleon exchange in the direct channel and one-pion exchange in the crossed channel are given, and the latter diagram is explicitly compared with the few experimental data available at present. (auth)

17079 ISOVECTOR CURRENT CONSERVATION AND RELATIONS FOR ELECTROMAGNETIC AMPLITUDES. Gribov, V. N.; Ioffe, B. L.; Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 387-98(Feb. 1967). (In Russian).

A relation between the amplitude for the scattering of a lepton pair (or a hypothetical vector meson) on a nucleon and the nucleon vertex-part is derived, assuming the conservation of the vector current with isospin 1 in the strong interactions. The meaning of such an equality is clarified by considering Feynman graphs. The Cabibbo–Radicati sum rule for the electromagnetic characteristics of hadrons is obtained in the zero momentum transfer limit if a subtractionless dispersion relation with respect to the energy can be written for one of the invariant functions of the amplitude. Arguments are given indicating that such an assumption may be wrong, even if the dispersion integral converges. An experimentally verifiable relation is found between $\nu + N \rightarrow N + 1 + \gamma$ reaction amplitude and the nucleon form factor. (auth)

17080 MESON PHOTOPRODUCTION ON NUCLEONS AND THE SU(6) SYMMETRY. Rekalo, M. P. Yadern. Fiz., 5: 435-45(Feb. 1967). (In Russian).

The s-state photoproduction of mesons on nucleons is considered in the SU(6)-symmetry. Relations between the corresponding reaction amplitudes are obtained, following only from the SU(6)-symmetry. A suppression of the coherent photoproduction of η-mesons on nuclei near to the threshold is predicted. Using the data on the photoproduction of π-mesons on nucleons near to the threshold, it is shown, that the dipole photoproduction model can be generalized to the photoproduction of strange particles and baryon resonances. It follows from the dipole model that the photoproduction amplitudes for charged pseudoscalar mesons are considerably larger than those for neutral mesons. The p-state photoproduction of mesons on nucleons is considered in the static SU(6)-model. In this model the p-state nonet of pseudoscalar mesons and octet of vector mesons belong to the 35 plet of SU(6). A number of relations between p-state photoproduction amplitudes is obtained. (auth)

17081 MAGNETIC MOMENT OF A BOUND QUARK AND THE COMPOSITE MODEL OF MESONS. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 458-64(Feb. 1967). (In Russian).

The magnetic moment of a Dirac particle in a potential well is considered. The ratio of the axial and vector constants is calculated using the experimental value of the proton magnetic moment. The obtained number is close to the experimental one. A relativistically invariant equation is considered for the composite model of mesons. An equation is obtained, analogous to that for the case of a factorizable potential, making it possible to determine the electromagnetic form factors of the mesons. (auth)

17082 ANGULAR AND ENERGY DISTRIBUTIONS OF PHOTONS ACCOMPANYING THE ANNIHILATION OF ELECTRON–POSITRON PAIRS INTO NEUTRINOS. Dzhafarov, I. G.; Safronov, A. N. (Moscow State Univ.). Yadern. Fiz., 5: 384-6(Feb. 1967). (In Russian).

The angular and energy distributions of photons, produced in the reaction $e^+ + e^- \rightarrow \nu + \bar{\nu} + \gamma$ are investigated. A formula is obtained for the total cross section of this process. (auth)

17083 ON THE DECAY OF PARTICLES WITH SPIN 0 AND 1 INTO THREE PHOTONS. Dolgov, A. D.; Ponomarev, L. A. (Inst. of Theoretical and Experimental Physics, State Committee for Uses of Atomic Energy, USSR). Yadern. Fiz., 5: 164-6 (Jan. 1967). (In Russian).

The general form of the amplitude for the decay of a scalar particle into three photons is obtained. It is shown that the minimal power of the momentum is seven. The general Lagrangian with the minimal number of derivatives is constructed for the decay of a vector particle. (auth)

17084 PHOTOPRODUCTION OF π^0-MESON ON NUCLEI. Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 167-73(Jan. 1967). (In Russian).

The first anomalous singularity with respect to the momentum transfer is taken into account in the π^0-meson photoproduction amplitude. The obtained "impulse approximation," modified by replacing the "asymptotical" form-factor by the more realistic one, gives a good agreement with experiment. (auth)

17085 SPIN-INDEPENDENT ISOVECTOR PART OF THE PHOTOPRODUCTION AMPLITUDE FOR NEUTRAL PIONS ON NUCLEONS. Govorkov, B. B.; Denisov, S. P.; Minarik, E. B. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 190-6 (Jan. 1967). (In Russian).

The energy dependence of the cross section was measured at the angle 70° for the neutral pion photoproduction on carbon nuclei. An analysis of the obtained results, based on the impulse approximation, made it possible to determine the energy dependence of the spin-independent isovector part of the amplitude for the pion photoproduction on nucleons and to compare it with calculations, based on dispersion theory. The experimental and theoretical values of the amplitudes are in excellent agreement. Small negative values are obtained for the amplitude M_{1-}, in agreement with dispersion theory calculations, if theoretical values of the M_{1+} amplitude are taken and the generalized shell model is used to calculate the nuclear form factor, for the mean square radius of the distribution equal to 2.2f. (auth)

17086 FLUCTUATIONS AND NUCLEAR INTERACTIONS IN THE ENERGY LOSS OF COSMIC-RAY MUONS. Kobayakawa, K. (Univ. of Utah, Salt Lake City). Nuovo Cimento (10), 47B: 156-84(Feb. 11, 1967).

The processes concerned with energy losses of high-energy muons, especially the nuclear interaction, are examined. From the energy loss relation $-(dE/dt) = k + bE$, the average range-energy relation is given, including the effects of nuclear interaction and without the assumption that b is independent of E. Effective quantities k_{eff}, b_{eff} are introduced. By using these, the average range-energy relation can be written in the same form as if k and b were constant. The fluctuations in energy loss of muons passing through a great thickness of material are studied. Numerical values of some functions which enter into an expression for the factor R, which corrects the fluctuations, are calculated by adopting more exact expressions of differential cross-section of the processes than those in past works. The values of R for standard rock are obtained and are compared with those given by other authors. The energy spectrum of muons at sea-level is discussed. (auth)

17087 STATISTICAL FLUCTUATIONS OF THE ENERGY LOSSES OF HYPERRELATIVISTIC ELECTRONS FROM RADIATIVE COLLISIONS. Baudinet-Robinet, Y. (Univ., Liege). Nuovo Cimento (10), 47B: 235-50(Feb. 11, 1967). (In French).

The construction of large and heavy-liquid bubble chambers initiated investigations of fluctuations of energy losses caused by bremsstrahlung of hyperrelativistic electrons. A simple method was developed to calculate the probability distribution — due to radiative collisions — of the residual energy of a hyperrelativistic electron, after passing through a finite thickness. Contrary to distributions obtained previously this distribution was found to be correct both with respect to the mean value and the standard de-

viation. Moreover, confidence limits for the initial energy of a hyperrelativistic electron are given, taking into account the energy losses due to invisible bremsstrahlung along that length of the track which was used for measuring multiple scattering. (auth)

17088 HARD PHOTON RADIATIVE CORRECTION TO WIDE ANGLE PAIR PRODUCTION. Huld, B. (Harvard Univ., Cambridge, Mass.). Phys. Lett., 24B: 185-7(Feb. 20, 1967).

The result of an exact calculation of the hard photon radiative correction to pair production is summarized. The result is surprisingly simple and suggests a more general applicability. (auth)

Weak

17089 (UR-875-187) TEN YEARS OF THE UNIVERSAL (V-A) THEORY OF WEAK INTERACTIONS. Marshak, R. E. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Feb. 14, 1967. Contract AT(30-1)-875. 33p. (CONF-670109-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

The formulation of the universal V−A theory for weak interactions over the past ten years is reviewed beginning with the invention of the Puppi triangle in 1948. Various problems still remaining in the domain of weak interactions are mentioned. (J.F.P.)

17090 POLE MODEL OF NONLEPTONIC HYPERON DECAYS, AND MODEL OF HADRONS AND THEIR FUNDAMENTAL WEAK INTERACTION. Fujii, Kanji; Murayama, Akihiro (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 36: 1185-1205(Dec. 1966).

The pole model of nonleptonic hyperon decays proposed by Kawasaki, Imoto and Furui (KIF) and Lee and Swift is re-examined for the purpose of establishing a connection between the phenomenology and subnuclear structure of hadrons and their weak interaction. It is assumed that there exist three urbaryons which play an essential role in composing hadrons. Baryons are assumed to be nonrelativistic bound states of three such urbaryons. Two types of hyperon models are considered: One is the quartet-like model (Model I), and the other is the quark-like model (Model II). The effective two-body weak hamiltonian between baryons becomes parity-conserving, and in a simplified limit in which all strong interaction corrections are neglected this hamiltonian is of the D or F type for Model I or II, respectively. In general, matrix elements of nonleptonic hyperon decays are written by using effectively five parameters. η (or η'), a member of the parameters, is introduced which is regarded as a measure of departure from the simplified limit. For any value of η (or η'), one can reproduce all the experimental data on nonleptonic hyperon decays including decay probabilities. This is possible only when the F/D ratio (a member of the five parameters) of the strong baryon-pseudoscalar-meson interaction is equal to ~(0.5 ~ 0.6). Consistency of the values of adjusted parameters with other phenomena is investigated. It is concluded that to regard the weak $J_\rho \cdot J_\rho^+$ interaction as the only fundamental interaction responsible for nonleptonic decays is unlikely, where J_ρ stands for an appropriate urbaryonic or Cabibbo-like current. It seems difficult at present to determine which of the two models is superior owing especially to the lack of knowledge of the parity-nonconserving amplitude. (auth)

17091 WEAK INTERACTIONS (SECOND SECTION). CHAPTER 8. DECAYS OF CHARGED K MESONS. Lee, T. D.; Wu, C. S. (Columbia Univ., New York). Annu. Rev. Nucl. Sci., 16: 471-510(1966). (NYO-1932-110).

A phenomenological analysis of the various decay modes of the charged meson (K) is presented. A systematic analysis of the information obtained from the study of various decay modes of mesons (K) using existing and future experiments is given. The logical consequences of various symmetry requirements are given individually, and possible tests of these symmetry principles, with particular emphasis on CPT and time reversal invariances are pointed out. (J.F.P.)

17092 WEAK INTERACTIONS (SECOND SECTION). CHAPTER 9. DECAYS OF NEUTRAL K MESONS. Lee, T. D.; Wu, C. S. (Columbia Univ., New York). Annu. Rev. Nucl. Sci., 16: 511-90(1966). (NYO-1932-110).

The phenomenological analysis and experimental information on neutral mesons (K) are reviewed. The general phenomenological analysis, including CPT invariance, and various decay modes are considered. (J.F.P.)

17093 NEUTRINOS IN ASTROPHYSICS AND COSMOLOGY. Chiu, Hong-yee (Goddard Inst. for Space Studies, New York. State Univ. of New York, Stony Brook). Annu. Rev. Nucl. Sci., 16: 591-618(1966).

The role of neutrinos in stellar evolution and cosmological processes is considered. The discussion includes neutrino emission processes in stellar structure, stellar evolution and neutrino emission, and the $(e\nu_e)$ $(e\nu_e)$ interaction and astronomical observations. (J.F.P.)

17094 DECAY $\Sigma^+ \to p\gamma$. Zakharov, V. I.; Kaidalov, A. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 369-78(Feb. 1967). (In Russian).

The imaginary part of the $\Sigma^+ \to p\gamma$ decay amplitude is calculated using the unitarity condition. The result is discussed from three different points of view: the possibility of obtaining information on the $\Sigma^+ \to n\pi^+$ decay mechanism from the decay $\Sigma^+ \to p\gamma$, the degree of unitary symmetry violation in the $\Sigma^+ \to p\gamma$ decay, the possible value of the difference between the $\Sigma^+ \to p\gamma$ and $\bar{\Sigma}^+ \to p\gamma$ decay probabilities, if T-invariance is violated badly in weak electromagnetic transitions. (auth)

17095 NEUTRINO ANNIHILATION OF A LEPTON-ANTILEPTON PAIR. Kerimov, B. K.; Dzhafarov, I. G.; Takvale, Ram; Yakh'yaev, P. Sh. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 32-9(May-June 1966). (In Russian).

A neutrino annihilation of a lepton-antilepton (electron-positron, and muon) pair in the lower order of perturbation according to the weak (V,A) interaction was investigated on the basis of the four-component and two-component neutrino theory. Formulas were obtained for differential and total cross sections with simultaneous account of the possible weak structural form factors of arbitrary lepton polarizations. The cross section of inverse process $\bar{\nu}_l + \nu_l \to l + l$ was also calculated. (tr-auth)

17096 BOSONIC LEPTONS. Weiner, Richard M. Phys. Rev. Lett., 18: 376-9(Mar. 6, 1967).

A more general possibility than that considered previously is suggested regarding the existence of bosonic leptons, namely those leptonic quantum number $n_L > 1$. It is shown that such particles exist in a more accessible mass range. Also it is possible that they have already been observed but because of an accidental mass degeneracy this was not realized. A concrete model is formulated for the bosonic leptons, and its experimental implications are discussed. It is expected that the bosonic lepton with the properties postulated may influence certain weak-interaction processes and may also offer an explanation for the controversial $\pi-\mu$ asymmetry. (J.F.P.)

17097 I = J = 0 DIPION STATE WITH A CDD POLE. Fujii, Y. (Tokyo Univ.). Phys. Lett., 24B: 190-3(Feb. 20, 1967).

An analysis of the dipion state with I = J = 0 (called the 0-0 state) without introducing a meson (σ) but assuming that a CDD pole dominates the inverse scattering amplitude is proposed. The success of the results seems to strongly support the validity of PCAC and current commutation relations applied to $\pi\pi$ scattering. (J.F.P.)

17098 THE NEUTRINO. Ghost Particle of the Atom. Asimov, Isaac. Books on Physics. Garden City, N. Y., Doubleday and Co., Inc., 1966. 234p. $4.95.

Beginning with explanations of the basic notions of momentum, energy, atomic structure, mass-energy, electric charges, and conservation laws, the story of the century-long chain of events that eventually proved the existence of the neutrino is traced. (L.B.S.)

Strong (General)

Refer also to abstract 17191.

17099 (CONF-660918-, pp 220-3) PERFORMANCE AND COST STUDIES FOR A MOUNTAIN ALTITUDE HIGH ENERGY COSMIC RAY BEAM FACILITY; LARGE SIZE PROPORTIONAL COUNTERS TO IDENTIFY THE HIGH ENERGY (≥100 GeV) CHARGED PARTICLES IN COSMIC RADIATION; A TOTAL ABSORPTION SPECTROMETER WITH DIGITIZED DATA READ OUT. Jones, L. W.; Ramana Murthy, P. V. (Michigan Univ., Ann Arbor); Radmer, C. A.; Winter, W. R. (Midwestern Universities Research Association, [Madison, Wis.]); March, R. H.; Subramanian, A. (Wisconsin Univ., Madison).

In a study aimed at using cosmic rays to explore strong interactions quantitatively over the energy range from 100 to 1000 GeV, a three phase program is outlined: the design optimization of a proposed full-scale facility, testing of prototype systems, and using these systems in a search for quarks. (B.G.D.)

17100 (JINR-P2-3115) O MODELI KVAZINEZAVISIMYKH KVARKOV. (On Quasi-Independent Quark Model). Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 30p. (In Russian). Dep. mn.

A nonrelativistic model of quasi-independent quarks is considered. It is used to obtain the baryon magnetic moments and the

relations for axial and vector constants and other parameters which agree well with experiment. (auth)

17101 (JINR-P2-3118) DISPERSIONNYE PRAVILA SUMM V TEORII SIL'NYKH VZAIMODEISTVII. (Dispersion Sum Rules in the Theory of Strong Interactions). Matveev, V. A.; Solov'ev, L. D.; Struminskii, B. V.; Tavkhelidze, A. N.; Shelest, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 58p. (In Russian). Dep. mn.

A detailed review on the dispersion sum rules in the theory of strong and electromagnetic interactions is given. The sum rules considered are based on the usual dispersion relations without using the algebra of currents. (auth)

17102 TESTS OF MODELS OF ELEMENTARY PARTICLES. Okubo, Susumu (International Center for Theoretical Physics, Italy). Progr. Theoret. Phys. (Kyoto), Suppl., No. 37-38, 114-40 (Dec. 1966).

By means of the algebra of currents, the validity of models of elementary particles was tested. From studies of the decay rate of $\pi_0 \rightarrow 2\gamma$, a calculation of the axial vector renormalization constant g_A, the decay rates of $V_9 \rightarrow 1 + \bar{1}$ and those of $V_9 \rightarrow P_8 + \gamma$ decays, it was concluded that the fractionally charged quark model of Gell-Mann and Zweig is the best candidate among all others. (auth)

17103 SCATTERING LENGTHS IN THE QUARK MODEL. Elitzur, M.; Rubinstein, H. R. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 18: 417-19(Mar. 13, 1967).

A set of predictions concerning scattering lengths is obtained by means of the quark model. The results, however, hold also for some form of U(6) ⊗ U(6) invariance at rest. (auth)

17104 SPIN AND PARITY TESTS FOR A RESONANCE STATE, DECAYING INTO TWO PARTICLES. Dubovikov, M. S. (Moscow Physical-Technical Inst.). Yadern. Fiz., 5: 419-27 (Feb. 1967). (In Russian).

Relations are obtained which can be used for an experimental determination of the spin and parity of a resonance state, decaying into two particles (resonances) with arbitrary spins. The general formulas are applied to the decays $j \rightarrow \frac{1}{2} + 1$, $j \rightarrow \frac{1}{2} + \frac{1}{2}$. The detection of the polarization characteristics, figuring in the relations, is considered. (auth)

17105 CERTAIN BOOTSTRAPS AND RELATED EQUATIONS. Broido, Michael M. (Princeton Univ., N. J. Courant Inst. of Mathematical Sciences, New York). J. Math. Phys. (N. Y.), 8: 1-6(Jan. 1967).

Methods of deriving existence and nonexistence theorems for certain classes of nonlinear integral and other equations are discussed. The methods are illustrated by examples from high-energy physics of equations of the bootstrap type. (auth)

Strong (Baryon No. = 0)

17106 (UCRL-17311) EQUIVALENT-POTENTIAL METHOD FOR RELATIVISTIC SCATTERING. Finkelstein, Jerome (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 26, 1967. Contract W-7405-eng-48. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The equivalent-potential method is generalized so as to permit calculation both of multichannel scattering and of certain scattering amplitudes of particles of nonzero spin. It is pointed out that amplitudes calculated by this method have correct dependence upon momentum transfer; it is argued that this feature may make the equivalent-potential method a better approximation to the unitarity iteration than is the N/D method. As examples, the $\pi\pi$, πK, and πN amplitudes are considered. For the first two of these cases it is found that the force due to vector meson exchange is far too small (it is suggested that inelastic effects may be quite important), but that if the input couplings are increased so as to reproduce the vector mesons, then 2^+ mesons are also produced, at roughly the masses of the $f^0(1250)$, $f^{0\prime}(1500)$, and $K^{**}(1405)$. In the πN case, with the potential given by nucleon and $N^*(1238)$ exchange, there are no free parameters in the calculation. The N^* is then "predicted" at a mass of 1100 MeV. The nonresonant phase shifts also agree in a general way with the results of phase-shift analysis; in particular, the S_{11} scattering length has the correct sign, while N/D calculations produce the wrong sign. It is argued that this result indicates that the force due to iteration of the potential, included in this method but not in N/D, can be important. (auth)

17107 BOSON MASS SQUARED FORMULA AND SPURIONS. DeCelles, Paul C. (Univ. of Notre Dame, Indiana). Nucl. Phys., B1: 216-18(1967). (COO-427-59).

The GMO mass formula for PS mesons was obtained directly in terms of the masses squared, to all orders in an S-PS-PS coupling constant, assuming that the principal contributions to δm^2 are due to the single-boson intermediate states and to the non-vanishing of the vacuum expectation values of some scalar fields. (auth)

17108 QUARK MODEL AND ANNIHILATION AT HIGH ENERGY. Kokkedee, J. J. J.; Van Hove, L. (CERN, Geneva). Nucl. Phys., B1: 169-79(1967).

Baryon-antibaryon annihilation contributions to high energy total cross sections are discussed in the quark model. It is argued that they cannot be included in the additivity assumption for quark amplitudes. In this modified form, additivity with isospin and charge conjugation invariance predicts four relations, two of which are in very good agreement with the data while the other two are at present inconclusive because of the large experimental uncertainties. Regarding annihilation cross sections, an alternative assumption of multiplicative type is proposed: it cannot be tested with present data. A few final remarks are given. (auth)

17109 APPLICATION OF CURRENT ALGEBRA TO PION EMISSION. Rubinstein, H. R.; Veneziano, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 18: 411-14 (Mar. 13, 1967).

It is shown that some calculations of pion emission based on current algebra need model-dependent corrections even in the limit of zero four momenta. The corrections are ambiguous and depend on the way in which the limit is reached. By means of Fubini's method general rules are obtained for determining when to expect the corrections. (auth)

17110 LOCALITY AND THE ISOSPIN OF SELF-CONJUGATE BOSONS. Carruthers, P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 18: 353-5(Mar. 6, 1967).

It is shown that the isospin operator is nonlocal for zero-spin bosons of half-integral isospin. (auth)

17111 SUM RULE FOR THE FOUR PION COUPLING CONSTANT RESULTING FROM CURRENT ALGEBRA. Kwiecinski, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 30: 1057-60(Dec. 1966).

Equal-time commutation relations with axial charges are applied in order to obtain the sum rule for the off mass shell $\pi\pi$ scattering amplitude at the symmetry point $s = u = t = 0$, which can be considered as approximating the $\pi\pi$ coupling constant, conventionally defined as the value of the $\pi\pi$ scattering amplitude at the symmetry point $s = u = t = \frac{4}{3} m_\pi^2$. (J.F.P.)

Strong (Baryon No. = 1)

17112 (CERN-67-3) SOME REMARKS CONCERNING THE PROTON STRUCTURE. Schopper, H. (European Organization for Nuclear Research, Geneva (Switzerland)). Feb. 16, 1967. 10p. Dep. mn.

A determination of whether the e−p and p−p results are consistent with each other and the general conclusions about the proton which can be drawn on this basis is made. It is emphasized that both the e−p and the p−p data can be fitted by two almost phenomenological expressions. This is connected with the difficulty in accelerating the various parts of the nucleon without breaking it up, and this difficulty is independent of the specific process. If, on the other hand, an optical potential is used to interpret the form factors and cross sections, it implies that the proton consists of two shells with radii of 0.8 and 0.35 f approximately. (J.F.P.)

17113 (LA-DC-8617) SINGLE π-PRODUCTION IN π-NUCLEON COLLISIONS. Young, J. E.; Rich, M. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 27p. (CONF-670207-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel.

The process $\pi + N \rightarrow 2\pi + N'$ is studied within the framework of simple models of the sort proposed by Amado, et al., and Lovelace. (auth)

17114 ON PION-NUCLEON SCATTERING AT HIGH ENERGIES. Hasebe, Katsuya (Nagoya Univ., Japan); Kanada, Hiroyuki; Otsuki, Shoichiro; Sawada, Shoji; Yasuno, Masaru. Progr. Theoret. Phys. (Kyoto), 36: 1301-3(Dec. 1966).

The analysis of polarization is extended to the higher energy region $P_L = 6$ to 10 GeV/c and to the differential cross section for the charge exchange process $\pi^- + p \rightarrow \pi^0 + n$ in the energy region 3 to 18 GeV/c. From this analysis it is expected that the polarization of $\pi^+ + p$ elastic scattering in the forward direction is large positive at a few GeV/c and diminishes as the energy increases and that the polarization of the charge exchange process is negative. (J.F.P.)

17115 THE PROCESS OF Σ-Λ CONVERSION FOLLOWING THE NUCLEAR ABSORPTION OF $\bar{K}$ WITH THE PRODUCTION

OF A π^-. Sawicki, J. (CERN, Geneva). Nucl. Phys., B1: 183-95(1967).

The second-order process of the Σ-Λ conversion following the nuclear absorption of a kaon from a $\overline{K}$ meso-atomic orbit with the production of a negative pion is discussed, and calculated from a second-order Feynman diagram. The momentum distributions of the recoiling nucleus and of the pion are computed for the $\overline{K}$ absorption in ^{4}He and in deuterium. A semi-quantitative agreement with the data is obtained in all the cases. No attempt is made to calculate the absolute values of the reaction rates in question. The need of more and better data is stressed. The available data tend to favor the assumption of the 2P capture over that of the 1S capture in the case of ^{4}He, but it is insufficient to rule out any one of the two cases. (auth)

17116 SCATTERING OF MESONS IN A MODEL WITH A FIXED NUCLEON. Gostev, V. B.; Frenkin, A. R. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 170: 803-6(Oct. 1, 1966). (In Russian).

Meson scattering on a fixed source was studied using a previously described model of the meson–nucleon system with a fixed nucleon in three possible states. (R.V.J.)

17117 TWO CHANNEL N/D CALCULATION OF THE p_{11} PARTIAL WAVE OF π N SCATTERING AT LOW ENERGIES. Bender, I.; Heiss, D.; Traenkle, E. (Freie Univ., Berlin). Z. Phys., 200: 332-42(1967).

The p_{11}-phase shift of πN scattering is calculated by a two-channel matrix N/D method using the reaction $\sigma N \rightarrow \sigma N$ as second channel. The calculated amplitude has the two main features of the p_{11} partial wave at low energies: the nucleon pole and the zero of the phase near the inelastic threshold. (auth)

17118 DISPERSION CALCULATION OF THE REAL PARTS OF THE FORWARD KAON-NUCLEON ELASTIC SCATTERING AMPLITUDES AT HIGH ENERGIES. Queen, N. M. (Univ. of Birmingham, Eng.). Nucl. Phys., B1: 207-15(1967).

Once-subtracted dispersion relations are used to calculate the real parts of the elastic kaon-proton and kaon-neutron forward scattering amplitudes at high energies. The results are sensitive to the KNΛ and KNΣ coupling constants and are found to be compatible with most of the experimental data and with Regge-pole model predictions only if the coupling constants are assumed to be substantially smaller than the values predicted by SU(3) symmetry. (auth)

17119 ANALYSIS OF THE ENERGY VARIATION OF BARYON BEHAVIOR IN INELASTIC π-N SCATTERING. Hulubei, H. (Bucharest Univ.); Andreescu, I.; Besliu, C.; Mihul, A.; Makarovitsch, I.; Mihul, E. Nucl. Phys., 87: 346-52(1966).

The behavior of the baryon produced in inelastic interactions is analyzed for different incident energies. The results are compatible with the absorption model in both cases of strange and nonstrange baryon production. (auth)

17120 N* PRODUCTION BY ρ MESON EXCHANGE. Bijtebier, J. (Univ., Brussels). Nucl. Phys., 87: 353-66(1966). (In French).

The amplitude of the reaction $\pi N \rightarrow \pi N^*_{\frac{1}{2}\frac{1}{2}}$ is expanded in partial waves. This will enable in the analysis of the experimental data the short-range part of the interaction to be represented by adjustable parameters and the long-range part by the contribution of one-ρ-meson exchange (Stodolsky-Sakurai model). (auth)

17121 ANTINUCLEON–DEUTERON INTERACTION IN THE IMPULSE APPROXIMATION. Nemirovskii, P. E.; D'yakonov, I. A. Yadern. Fiz., 5: 277-87(Feb. 1967). (In Russian).

The application of the impulse approximation to scattering on deuterons in the case of strong absorption (annihilation) is considered. It is shown that the impulse approximation makes it possible to determine the absorption scattering cross section. The spin and isospin of the interacting particles are also treated. (auth)

17122 SPIN STRUCTURE OF THE AMPLITUDE FOR THE PRODUCTION OF f^0 MESONS IN HIGH ENERGY πN COLLISIONS. Karnakov, B. M.; Kelner, S. R. (Moscow Engineering Physics Inst.). Yadern. Fiz., 5: 411-18(Feb. 1967). (In Russian).

The spin structure and kinematical singularities of the invariant functions in the amplitude of the process $\frac{1}{2}^+ + 0^- \rightarrow \frac{1}{2}^+ + 2^+$ is investigated. The high energy asymptotic behavior of the amplitude is considered, using the complex angular momentum method. In the case of f^0-meson production ($J^{PG} = 2^{++}$) the angular distribution of the $f^0 \rightarrow 2\pi$ decay products is obtained for various quantum numbers of the dominating singularity in the complex j-plane. Zero angle f^0-meson production is considered. The possible form of the angular distribution of pions from the decay $f^0 \rightarrow 2\pi$, produced at energies of the order 10 GeV (l.s.), is discussed. (auth)

17123 CP-NONINVARIANT CORRELATION IN THE PROCESSES $(\pi^-p) \rightarrow n + e^+ + e^-$ AND $(K^-p) \rightarrow \Lambda + e^+ + e^-$. Colic, P.; Tsukerman, I. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 453-7(Feb. 1967). (In Russian).

The dependence of the polarization, perpendicular to the reaction plane, in processes of the type $A \rightarrow B + e^+ + e^-$ (A and B are arbitrary hadron systems), on the form factors and on the square of the invariant mass of the electron-positron pair, is analyzed. The maximal polarization of the Λ hyperon in the capture of K^- mesons at rest $(K^-p) \rightarrow \Lambda + e^+ + e^-$ is estimated. The contribution to the polarization, due to open channels in the process through intermediate states with particles on the mass shell is calculated. Estimations show that this effect is negligible and cannot mask the CP-noninvariant polarization in the π^- capture ($\pi^-p \rightarrow ne^+e^-$), but is predominant in the K^- capture. (auth)

17124 HADRON BREMSSTRAHLUNG AT HIGH ENERGIES. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 399-404(Feb. 1967). (In Russian).

It is shown that the region in which the usual formulas for accompanying radiation can be applied expands significantly as the energy increases. This is a result of the cancellation of various Feynman diagrams, due to the charge conservation. The result makes it possible to calculate asymptotically the total bremsstrahlung cross section. (auth)

17125 ON Λ-PARTICLES CREATION IN K^+p-COLLISIONS AT HIGH ENERGIES. Majumdar, Rabi; Gupta, K. C. (Moscow State Univ.). Yadern. Fiz., 5: 185-9(Jan. 1967). (In Russian).

The reaction $K^+p \rightarrow K^+K^+\Lambda$ cross section at high energies is calculated with the distorted waves technique in Born approximation taking into account one-meson exchange only. The four-kaon vertex is obtained by means of the N/D-method. The total cross section of the Λ-hyperon creation calculated in this way is discussed and compared with the available experimental data. (auth)

17126 SUPERCONVERGENCE RELATIONS IN THE PRESENCE OF REGGE CUTS. Muzinich, I. J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 18: 381-2(Mar. 6, 1967).

It is pointed out that even though there is no evidence for I = 2 Regge trajectories with $\alpha_{I=2} > 0$, there are Regge cuts with I = 2 that will generally invalidate the I = 2 superconvergence relations. It is shown that there exist cuts with the property that $\alpha_{cut} > 0$. (J.F.P.)

17127 DISPERSION-THEORETIC APPROACH TO CURRENT ALGEBRAS. Fuchs, Norman H. (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett., 18: 373-6(Mar. 6, 1967).

It is shown how the assumption of pole-dominated unsubtracted dispersion relations may be used to derive results previously obtained on the basis of current commutation relations. (auth)

17128 Λ AND Σ^0 PRODUCTION IN PERIPHERAL REACTIONS. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel); Scheck, Florian. Phys. Rev. Lett., 18: 347-8(Mar. 6, 1967).

A suppression of Σ^0 production relative to Λ production by a factor of 27 is predicted in transitions with baryon spin flip in several simple models using SU(6) wave functions for the baryons. Possible experiments to detect this factor are suggested. (auth)

17129 WIDE ANGLE PAIRS PRODUCED IN πN INTERACTIONS. Dass, G. V. (Atomic Energy Research Establishment, Harwell, Eng.); Ross, M. Phys. Lett., 24B: 175-8(Feb. 20, 1967).

The direct photon-vector meson coupling scheme is used to relate $\pi N \rightarrow \rho N$, $\gamma N \rightarrow \pi N$ and $\pi N \rightarrow e^+e^-N$. The production of wide angle pairs by 830 MeV pions is satisfactorily explained. (auth)

17130 TESTS OF SUM RULES BASED UPON THE REGGE POLE MODEL. Hsu, Jong-ping; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Lett., 24B: 179-81(Feb. 20, 1967). (UR-875-178).

Sum rules in the high-energy scattering problem which were derived on the basis of Regge pole models are studied in further detail. A comparison is made with experimental data. (TSS)

17131 HIGH-ENERGY BEHAVIOR OF FEYNMAN INTEGRALS WITH SPIN. II. Greenman, J. V. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. J. Math. Phys. (N. Y.), 8: 26-36(Jan. 1967). (MIT-2098-231).

A previous analysis is applied to determine the leading behavior and coefficients of specific lower-order terms of planar graphs in the nucleon–meson scattering process. The results of Cheng and Wu in verifying the Reggeization hypothesis in sixth order are rederived and a method of extending the analysis to nth order is indicated. (auth)

17132 DISPERSION SUM RULES AND HIGH ENERGY SCATTERING. Logunov, A. A.; Solov'ev, L. D.; Tavkhelidze, A. N.

(Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 181-2(Feb. 20, 1967).

Dispersion sum rules which connect the high-energy scattering parameters with the integrals of low-energy cross sections are obtained. (auth)

17133 K^--p CHARGE EXCHANGE SCATTERING AT 1.51 AND 1.7 GeV/c. Minami, S. (Osaka City Univ.). Phys. Lett., 24B: 188-90(Feb. 20, 1967).

It is shown that the $d\sigma/d\Omega$ for K^--p charge exchange scattering at 1.5–1.7 GeV/c can be well described in terms of the direct resonance amplitudes and the ρ-exchange amplitude. The polarization of recoil nucleons is predicted with the same model. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 17112.

17134 (AECD-TP-15) PHASE SHIFT CALCULATIONS FOR REAL AND REALISTIC POTENTIALS. Ali, Shamsher; Islam, Mozaharul (Atomic Energy Centre, Dacca (Pakistan)). Sept. 1966. 14p. Dep. mn.

Real and central potentials are considered in the program presented and a procedure for phase shift calculations is developed which can be readily used for all types of realistic potentials. This program also incorporates the calculation of the low-energy effective range parameters, namely, scattering length and effective range. (J.F.P.)

17135 (JINR-P4-3135) OPISANIE UPRUGOGO NUKLON-NUKLONNOGO RASSEYANIYA V MEZONNOI MODELI YADERNYKH SIL. (Description of Elastic NN-Scattering in Meson Model of Nuclear Forces). Babikov, V. V.; Kiselev, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 16p. (In Russian). Dep. mn.

The phase shifts of elastic NN-scattering with the orbital momenta $L \geq 1$ for the energy range of $E_{Lab} \lesssim 330$ MeV are calculated on the basis of an assumption that the external region of nuclear forces is determined by the exchange of the lightest π, η, ρ, ω, s mesons. The momentum dependence of the potentials is calculated in the Born approximation. The constants of meson-nucleon coupling are found which lead to a satisfactory description of experimental P, D.F, G scattering phase shifts. It is shown that these values agree with those of the coupling constants, determined from other experimental data. (auth)

17136 (JINR-P4-3136) SOVREMENNYE MODELI YADERNYKH SIL. (Modern Nuclear Force Models). Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 10p. (In Russian). Dep. mn.

Different models of nucleon-nucleon interaction, used in nuclear physics, are discussed. (auth)

17137 PHASE SHIFT ANALYSIS AND REAL AMPLITUDE OF HIGH ENERGY PROTON-PROTON ELASTIC SCATTERING. Hama, Mitsuru; Kawaguchi, Masaaki (Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1154-66(Dec. 1966).

Phase shifts δ_l and the absolute values η_l of the partial wave S matrix elements are evaluated for proton-proton scattering up to $l = 30$ in the energy region of 10 to 25 GeV/c. Orear's formula $(d\sigma/d\Omega) = B^2p^2e^{Bt} + (A/s)e^{-\alpha p\sin\theta}$, where the first term comes from the imaginary amplitude and the second is attributed to the real part, is assumed. No spin dependence is assumed. The results show that the asymptotic behavior of δ_l for low partial waves has the two possibilities: δ_l is negative, increases and tends to zero, or decreases and tends to –90° as the energy increases. This fact depends critically on the values of B and γ. The partial wave unitary relation still holds up to $l = 30$, which was shown by Sumi to be violated for large l in the eikonal approximation. Next the contribution to the imaginary part from the elastic intermediate state is shown to dominate over inelastic states at rather small momentum transfer $t \approx -0.6$. Finally a possible form of the real amplitude is given from the imaginary part with the exponential t-dependence and the one-pion-exchange model, by taking absorption into account. For the simple and extreme case the ratio of the real to the imaginary part is about –0.5 in the forward angle. (auth)

17138 ONE-BOSON-EXCHANGE MODEL PARAMETERS AND NN-SCATTERING PHASE SHIFTS. Azhgirei, L. S.; Chizhikov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 405-10(Feb. 1967). (In Russian).

The parameters of a one-boson-exchange model are determined from the nucleon nucleon scattering phase shifts in the region 25 to 310 MeV, using the method of least squares. In a four-pole model, allowing for the exchange of scalar (σ), pseudoscalar (π) and two vector (ω and ρ) mesons, the best description of the nucleon-nucleon scattering corresponds to the following values of the parameters: $g_\omega^2 = 2.1 \pm 0.5$; $f_\omega/g_\omega = 0.5 \pm 0.1$; $m_\omega = 422 \pm 18$ MeV; $g_\sigma^2 = 2.9 \pm 0.4$; $m_\sigma = 373 \pm 13$ MeV; $g_\pi^2 = 13{,}1 \pm 0.2$; $g_\delta^2 = 0.1 \pm 0.3$; $f_\rho/g_\rho = -5.4 \pm 7.0$; $m_\rho = 800 \pm 140$ MeV. The energy dependences of the phase shifts, calculated using these parameters, are compared with the results of phase shift analyses at 435 and 657 MeV. (auth)

17139 SPIN CORRELATION TENSOR IN THE SCATTERING OF POLARIZED NUCLEONS BY POLARIZED PROTON TARGET. Winternitz, P.; Legar, F.; Yanout, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 201-3(Jan. 1967). (In Russian).

Experiments to measure the tensor of spin correlation from the scattering of a polarized nucleon beam by a polarized proton target are discussed. Relativistic formulas for measurable quantities are obtained. A construction of the scattering matrix with experimentally measurable quantities is performed. (auth)

Particle Invariance Principles and Symmetries

General

17140 (JINR-E2-3089) CP-VIOLATION AS CONSEQUENCE OF GEOMETRIZATION OF MAXWELL FIELD. Arbuzov, B. A.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 25p. Dep. mn.

The geometric interpretation of the CP-violating interaction which was proposed earlier, is given. The space with vanishing Riemannian curvature, with usual Minkovsky metrics, but with nonvanishing torsion is considered. It is shown, that this space is completely defined by some antisymmetric tensor of the second rank, which is naturally related to the tensor of the electromagnetic field. Simple geometric considerations lead to equations, which generalize the Maxwell equations. It is shown that the spinor particle in this space certainly has the CP-violating interaction. (auth)

17141 ON THE CLEBSCH-GORDAN COEFFICIENTS OF THE SU(n)-GROUP. Shelepin, L. A.; Karasev, V. P. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 5: 221-8(Jan. 1967). (In Russian).

A method of constructing Clebsch–Gordan coefficients for the SU(n)-group in a symmetrical (generalized spinor) basis is developed using the $n \times n$ symbols. An analytical expression for the SU(3)-group Clebsch–Gordan coefficients is obtained and formulas are given, realizing the transition from the symmetrical basis to the canonical one, characterized by the hypercharge, the isospin, and its projection. (auth)

17142 SOME REMARKS ABOUT THE DISPERSIVE APPROACH TO SYMMETRY BREAKING. Calucci, Giorgio (Istituto Nazionale di Fisica Nucleare, Trieste, Italy. Univ., Trieste, Italy). Nucl. Phys., 87: 326-30(1966).

In the problem of deriving sum rules from the equal-time commutation relations, some difficulties arise from the kinematical variables of the states. These difficulties have been recently dealt with by means of a dispersive approach. An attempt is made to maintain a covariant formulation without using dispersion relations. (auth)

17143 INTRODUCTION TO GROUP THEORY AND TO UNITARY SYMMETRY MODELS. de Franceschi, G. (CNEN, Frascati, Italy); Maiani, L. Fortschr. Phys., 13: 279-384(1965).

The discussion of group theory and unitary symmetry models includes general notions of groups, linear spaces, representations of groups and of a compact Lie group, the Kronecker product of representations, Schur's lemma and the Wigner–Eckart theorem, symmetry principles in elementary particle physics, and the structure of semisimple Lie algebras. Also discussed are representations of semisimple Lie algebras, the eightfold way, electromagnetic interactions, and leptonic decays of hadrons. (J.F.P.)

17144 REPRESENTATIONS OF INHOMOGENEOUS SU(n) GROUPS WITH MIXTURE OF HOMOGENEOUS AND INHOMOGENEOUS OPERATORS DIAGONAL. Mirman, Ronald (Long Island Univ., Brooklyn). J. Math. Phys. (N. Y.), 8: 57-62(Jan. 1967).

Explicit representations of some inhomogeneous compact SU(n) groups and their algebras are constructed with certain mixtures of diagonal homogeneous and inhomogeneous operators. (auth)

17145 GENERAL COUPLING COEFFICIENTS FOR THE GROUP SU(3). Resnikoff, M. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 8: 63-79(Jan. 1967).

A Hilbert space method, previously applied to the group SU(2), is employed to examine the representations $D^{\lambda\mu}$ and the reduction of the direct-product representation of the group SU(3). The base vectors $|\lambda\mu;\alpha\rangle$, an orthogonal Hilbert space of homogeneous polynomials, are transformed to the base vectors $|\lambda\mu;\alpha\rangle_c$, and are associated with the complex conjugate representation by an explicit R- conjugation operation. For the general direct-product representation $D^{\lambda_1\mu_1} \otimes D^{\lambda_2\mu_2}$, explicit expressions are derived for the vector coupling coefficients and the number of times the irreducible representation $D^{\lambda_3\mu_3}$ is contained in the direct product. Two methods of labeling the degenerate states are given, the reduction of the direct product is shown to be complete, and the symmetry relations of the 3($\lambda\mu$) coefficients are discussed. (auth)

17146 RECOUPLING COEFFICIENTS FOR THE GROUP SU(3). Resnikoff, M. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 8: 79-83(Jan. 1967).

The Hilbert space method, employed in the previous article to obtain the coupling coefficients of SU(3), is used here to obtain the recoupling, or 6($\lambda\mu$), coefficients of SU(3). The coefficients are formulated in terms of a generating function involving an integral, and an explicit expression is integrated out for the general nondegenerate case. The symmetries of the 6($\lambda\mu$) coefficients are discussed. (auth)

17147 UNITARY SYMMETRIES AND THEIR APPLICATION TO HIGH ENERGY PHYSICS. Gourdin, Michel. New York, John Wiley and Sons, Inc., 1967. 312p. $12.75.

SU(3) and SU(6) are discussed. Besides the algebra of the group and the classification of particles, the role of SU(3) in strong, electromagnetic, and weak interactions is studied, and comparison between theory and experiment is discussed. The extension of the SU(3) symmetry to the SU(6) symmetry where space–time properties of the particles are introduced, is examined and many of the difficulties to preserve Lorentz invariance are exhibited. The interpretation of SU(6) symmetry with the so-called algebra of currents is briefly discussed. Problems of topology are surveyed. The standard form of semi-simple Lie algebra and the classification of simple algebra due to Cartan are studied. The theory of representations is presented in the particular case of compact groups for which all representations are equivalent to unitary representations. Tensor algebra, Young diagrams, and products of representations are also considered. (C.E.S.)

Applications (Electromagnetic and Weak)

17148 CURRENT ALGEBRAS AND SU_3 VIOLATIONS. Renner, B. (Univ. of Cambridge, Eng.). Nucl. Phys., 87: 337-45(1966).

A systematic investigation is given of generalized Adler-Weisberger relations to test current algebras in broken SU_3. No use is made of concepts of SU_3 symmetry as input information (like D/F ratios or relations between the K- and π-meson leptonic decays), but enough current algebra predictions are collected to determine all necessary parameters without using SU_3 symmetry. As a result relations are found between observed SU_3 violations, enhancement of the K_{l2} decay rate and suppression of the K-meson Yukawa coupling due to the higher mass of the K-meson. Numerical estimates are given and a comparison to experimental values is made, but the present error limits allow only an observation of the general trends. (auth)

17149 POSSIBLE CP-NONINVARIANT EFFECTS IN $\pi\pi\gamma$ DECAY OF CHARGED K MESONS. Costa, G.; Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev. Lett., 18: 429-31(Mar. 13, 1967).

Radiative 2π decays represent one of the few processes where one may reasonably hope to see relatively large CP-noninvariant effects. A phenomenological discussion is given of the various effects which may occur. (auth)

17150 A POSSIBLE RESTRICTION ON CP-NONINVARIANCE IN K^0-DECAY. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Nature, 213: 898(Mar. 4, 1967).

It is stated that the generally accepted interpretation (which is the only remaining explanation within the framework of quantum mechanics) of the observed $K_2^0 \to 2\pi$ decays is that this is a manifestation of some CP-noninvariant interaction. Despite a variety of suggestions as to the nature of the CP-noninvariant interaction, so far there has been no clear indication of CP-noninvariance in any other process, and ignorance remains of the origin and nature of the interaction responsible for $K_2^0 \to 2\pi$ decays. In the absence of a basic theory, the present communication considers a restrictive simplifying assumption, which does not conflict with any known result and which fixes the parameters for $K_2^0 \to 2\pi$ decay. The condition discussed is $\langle K_1^0|H|K_2^0\rangle = 0$, where K_1^0 and K_2^0 are the linear superpositions of K^0 and $\bar{K}^0$ states which are characterized by a purely exponential time dependence in the Weisskopf-Wigner approximation. (UK)

17151 THE $\eta^0 \to \pi^0 + e^+(\mu^+) + e^-(\mu^-)$ DECAYS AND CP-PARITY VIOLATION. Solov'ev, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 428-34(Feb. 1967). (In Russian).

The spectra and probabilities of the decays $\eta^0 \to \pi^+ + e^+(\mu^+) + e^-(\mu^-)$ are considered according to the scheme $\eta^0 \to \pi^0 + \gamma \to \pi^0 + e^+(\mu^+) + e^-(\mu^-)$ with CP violation, and according to the scheme $\eta^0 \to \pi^0 + 2\gamma \to \pi^0 + e^+(\mu^+) + e^-(\mu^-)$ with CP conservation. Two possible CP-violation mechanisms are considered in the calculations: 1) the semistrong X_0^+ interaction and 2) maximal CP violation in electromagnetic interactions. (auth)

17152 PRODUCTION OF BARYONS BY HIGH ENERGY NEUTRINO BEAM AND $\tilde{U}(12)$-SYMMETRY. Laperashvili, L. V. (Inst. of Physics, Academy of Sciences, Georgian SSR). Yadern. Fiz., 5: 211-14(Jan. 1967). (In Russian).

Differential cross sections of the neutrino production of baryons belonging to the SU(3) octet are considered assuming that the effective hadron weak current has the U(12)-symmetry. Two forms of weak form factors in the pole approximation model in the "kineton" scheme of the $\tilde{U}(12)$ theory are used. (auth)

Applications (Strong)

17153 BARYON NUMBER CHANGING CURRENTS. Miyazawa, Hironari (Argonne National Lab., Ill. Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1266-76(Dec. 1966).

An attempt is made to generalize the algebra of currents by inclusion of baryon number changing currents which connect baryons and mesons. In this algebra both baryons and mesons are grouped together in a representation, i.e., in a supermultiplet. The currents are constructed from a set of fundamental particles consisting of a spinor SU(3) triplet and a scalar triplet. Most of the important hadrons are included in a supermultiplet but the baryon decimet is not. The hadrons discussed here correspond to bare hadrons without the Yukawa interactions. Mass relations, cross sections and other consequences obtained from this symmetry scheme are discussed. (auth)

17154 REPRESENTATION MIXING AND SUM RULES FOR MAGNETIC MOMENTS FROM CURRENT COMMUTATION RELATIONS. Matsuda, Satoshi (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1277-82(Dec. 1966).

The commutation relation satisfied by the electric dipole moment operators is considered within the representation mixing scheme. By noting that the expectation value of the dipole moment operator for the nucleon at infinite momentum in the Z direction is the anomalous magnetic moment and its transformation property under the algebra U(3) × U(3) is $\{(8,1)_0 + (1,8)_0; L_z = \pm 1\}$, it is shown that from the commutation relation of the dipole moment operators a sum rule is derived which relates the anomalous magnetic moments of the proton and neutron with the isovector charge radius, where the assumption is made that the commutator is saturated by a few low-lying resonances. If the contribution of the second nucleon resonance N**(1512) to the commutator is taken into account, in addition to that of the nucleon and N*(1238), the sum rule predicts a reasonable value for the isovector rms charge radius. (auth)

17155 MASS LEVELS OF HIGHER MESON RESONANCES. Kitakado, Shinsaku; Ninomiya, Kansuke; Ohnuki, Yoshio; Toyoda, Akira (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 1206-18(Dec. 1966).

The mass levels of higher meson resonances are investigated by assigning them to the 189-dimensional representation of SU(6). The mass formula with symmetry breaking terms M_{35}^1, M_{189}^1, and M_{405}^1 shows satisfactory agreement with the experimental mass values so far reported. The mass formula for the 405 representation of SU(6) is also calculated. (auth)

17156 DYNAMICAL MODEL FOR THE DBP AND BBP COUPLING CONSTANTS IN THE BROKEN SU(3) SYMMETRY. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theoret. Phys. (Kyoto), 36: 1167-84(Dec. 1966).

The self-consistency condition for the third order vertex is used to obtain the self-consistent DBP and BBP coupling constants in the broken SU(3) symmetry, where D, B and P denote $J^P = 3/2^+$ baryon decuplet, $1/2^+$ baryon octet and 0^- meson octet respectively. The symmetry breaking part in masses and interactions is assumed to transform like a T = Y = 0 component of an octet and the first-order approximation is made for the shifts of masses and the coupling constants from symmetry limit. The scattering parts (the B and D exchanges are taken into account) of the related vertices are approximated by the static poles. Even by this approximation, still a logarithmic divergence remains in the calculation

of the vertex functions. Therefore a cutoff is introduced so that the resulting $NN\pi$ coupling constant may agree with observation. In this way a set of nine simultaneous linear equations for nine unknown parameters is obtained which gives the shifts of the DBP and BBP coupling constants, putting all the masses to the observed values which obey the Gell-Mann-Okubo mass formula. The numerical values of the BBP coupling constants thus obtained agree with experiment and also with the results of Chan and Sarker based on the broken SU(6) symmetry qualitatively. However, in the DBP case agreement with experiment and also with the theoretical results is not good. The apparent connections between previous theoretical results for the DBP coupling constants are also discussed in some detail. (auth)

17157 SATURATION, STATIC SU(2)-MODEL AND DYNAMICAL SYMMETRIES. Pande, L. K. (International Center for Theoretical Physics, Trieste, Italy). Phys. Lett., 24B: 243-5 (Mar. 6, 1967). (IC-67/3).

It is shown that the assumption of saturation of certain superconvergence relations by nucleon and the nucleon isobars leads, within the static SU(2)-model, to coupling relations which are identical to those following from the group $SU(2)_I \otimes SU(2)_S \otimes T_3$, with the nucleon and the isobars belonging to the representation of this group which is characterized by $I = J = 1/2, 3/2, 5/2, \ldots$. (auth)

17158 ON ϕ-ω MIXING WITHOUT SYMMETRY BREAKING. Formanek, J. (Faculty of Technical and Nuclear Physics, Prague). Nucl. Phys., 87: 376-80(1966).

Irreducible representations of the Lie algebra G contain generally several irreducible representations of the intrinsic symmetry subalgebra SU(n). One class of such representations is discussed here. It is shown that for n = 3 there is an irreducible representation suitable for classification of nine particles. Corresponding mass formula and SU(3) content are in very good agreement with experiment for the case of the vector meson nonet. (auth)

17159 ALGEBRAIC ASPECTS OF REGGE RECURRENCES. Gotsman, E.; Ne'eman, Y. (Tel-Aviv Univ., Israel). J. Math. Phys. (N. Y.), 7: 2174-7(Dec. 1966).

The algebraic structure of Regge recurrences is examined, and its relation to symmetry schemes underlying various models is established. The relationship between the spectrum generating algebras (SGA) and the noncompact subalgebras of the rotational states are discussed for the Coulomb potential, the three-dimensional oscillator, the signature which appears in exchange potentials, as well as the U(6,6) and the other suggested SGA of hadron physics. (auth)

17160 THE REPRESENTATIONS 189 AND 405 OF SU(6) AND THE CLASSIFICATION OF 2^+, 1^+, AND 0^+ MESON RESONANCES. Enkovski, L.; Kukhtin, V. V.; Nguyen Van Hieu (Inst. of Physics, Academy of Sciences, Georgian SSR). Yadern. Fiz., 5: 215-20 (Jan. 1967). (In Russian).

A possible classification of 2^+, 1^+, and 0^+ meson resonances with respect to the SU(6) group is considered. The mixing between various unitary multiplets with identical spins is investigated. The C-parities of particles in a given multiplet are determined and relations are obtained between the constants of $2^+ \to 0^- + 0^-$, $0^+ \to 0^- + 0^-$, $2^+ \to 1^- + 0^-$ and $1^+ \to 0^- + \gamma$ decays. (auth)

17161 ON THE MAGNETIC MOMENTS OF BARYONS. Zaretskii, D. F.; Ivanter, I. G. Yadern. Fiz., 5: 204-10(Jan. 1967). (In Russian).

A simple dynamical model is used to calculate the magnetic moments of the baryon 56-plet. The results are compared with the predictions of the SU(3)- and SU(6)-symmetry theories and existing experimental data. Possible experimental tests of the suggested model are discussed. (auth)

17162 THEORETICAL DISCUSSIONS CONCERNING η'-δ DEGENERACY. Tuan, S. F. (Inst. for Advanced Study, Princeton, N. J.); Wu, Tai Tsun. Phys. Rev. Lett., 18: 349-53(Mar. 6, 1967).

The consequences of the proposition that the mass degeneracy of the mesons (δ) and (η') is not accidental is investigated. The analysis is restricted to those internal symmetry groups which commute with the Lorentz transformation. (J.F.P.)

17163 MASS FORMULAS IN THE INHOMOGENEOUS SU(6,6) GROUP. Nicolov, A. V.; Todorov, I. T. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 185-97(1966). (In Russian).

A symmetry breaking for the inhomogeneous SU(6,6) group is introduced in the following way: it is required that the commutators of the 143-momentum P with isospin and hypercharge give zero when acting on physical states. Using this and the invariance of $\mathrm{Tr}P^2$, quadratic mass formulas are obtained both for mesons and baryons. For the mesons the obtained relations are satisfied within an accuracy greater than 1%. The agreement of the mass formulas for baryons with experiment is not so good. (auth)

17164 UNITARY SPIN AS PRODUCED FROM INTERNAL SPIN. Takabayasi, Takehiko; Kase, Hiromi (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 1307-8(Dec. 1966).

It is shown that if the original defining representation of SU(3) is considered, this is produced out of an O(3) algebra distinct from the isospin subalgebra SU(2), via the process of multiplicative closure. The procedure is analogous to the completion of the original Dirac matrices γ_μ into the 15 γ_A, which are closed under mutual multiplication giving the basic representation of SU(4). (J.F.P.)

17165 SUM RULES FOR VVP COUPLING CONSTANTS IN BROKEN SU(3), BASED ON THE GOLDBERGER-TREIMAN RELATIONS. Ghose, P. (Indian Association for the Cultivation of Science, Calcutta). Progr. Theoret. Phys. (Kyoto), 36: 1303-4(Dec. 1966).

Since the method using the Goldberger-Treiman relations gives new results not obtainable by conventional perturbative techniques, it is used to obtain new sum rules for VVP coupling constants in broken SU(3). For this purpose the Kemmer equation $(\beta_\mu p_\mu - im)\phi(p) = 0$ for vector mesons with the β's satisfying the Kemmer-Puffin algebra is used. (J.F.P.)

17166 HIGHER SYMMETRIES IN ELEMENTARY PARTICLE AND FIELD THEORY. Aghassi, Jacob Jamil. Boston, Boston Univ., 1966. 89p.

Thesis.

In this dissertation, the theory of Lie groups is applied to the study of elementary particles and their symmetries. A first example is provided by the de Sitter group, L_5, which is taken as the group of transformations in space-time. The inhomogeneous Lorentz group, usually given this role, is regarded as an approximation valid only in the limit of vanishing curvature. Within the rigid de Sitter background, a unified description of fields is provided by the representations of L_5, and its invariants. In particular, gravitation is introduced by a Yang–Mills type nonAbelian gauge principle, where the gauge group is that of L_5 transformations with coordinate-dependent parameters. The compensating field is found to be a de Sitter tensor of rank four with two pairs of anti-symmetric indices, which spans a 35-dimensional representation of L_5. This field is coupled to a conserved current which unifies the energy-momentum tensor with the angular-momentum tensor. As a result, the compensating field can be identified with the gravitational field. This procedure has the advantage of allowing gravitation to be treated on equal footing with other fields, thus allowing its quantization without introducing ambiguities in the description of space-time. Details and consequences of this scheme are worked out. A second example of applying Lie group concepts is given by the recent attempts to unify space-time with the internal symmetries of elementary particles. This is accomplished by treating the quarks of SU_3 as spinors in L_5. This is followed by the assumption of invariance of strong interactions under spin and unitary spin transformations, which gives the extended symmetry under the noncompact SU_{12} group. Mesons transform according to the regular representation of this group, of dimension 143, and separate, when the symmetry is broken, into the 0^- octet (π, k, η), the 1^- octet (ρ, k*, ω) the 0^- singlet (X^0 ~950 MeV) and the 1^- singlet, ϕ. The baryons are constructed from a symmetric rank three tensor of dimension 364, and separate, under $SU_{12} \to SU_3 \otimes L_5$, into a $1/2^+$ octet, a $3/2^+$ decuplet, a $1/2^+$ singlet, and a $3/2^-$ octet. These are identified with the various long-lived baryons and baryon resonances discovered recently. A mass formula is derived, and further dynamical consequences are discussed. (auth)

Quantum Field Theories

17167 GALILEAN QUANTUM FIELD THEORIES AND A GHOSTLESS LEE MODEL. Levy-Leblond, Jean-Marc (Faculte des Sciences, Nice). Commun. Math. Phys., 4: 157-76(1967). (UR-875-145).

Galilean quantum field theories, i.e., kinematically consistent nonrelativistic quantum theories with an infinite number of degrees of freedom, are considered. These theories transcend the frame of ordinary quantum mechanics by allowing genuine particle production processes to be described. The general structure of such theories is discussed and contrasted with the typical structure of relativistic quantum field theories which they may serve to illustrate a contrario. Despite the mass superselection rule, and due to the weakening of local commutativity conditions, galilean quantum field theories are much less constrained than relativistic ones. The CPT and spin-and-statistics theorems do not hold here, neither does Haag's theorem. Second-quantized quantum mechanics, some many-body theories (such as the polaron model) and static models are briefly examined, giving simple examples and counterexamples of the general properties asserted. A Lee model with complete

nonrelativistic kinematics is studied and shown to give a consistent non-trivial example of a galilean quantum field theory. In this "GaliLee" model, while all the desirable features of the usual Lee model remain, the ghost problem disappears and the local coupling limit gives meaningful expressions for the physical quantities. The ($V \rightleftharpoons N\theta$) sector is solved for the physical V-particle whose renormalization constant is finite for local coupling, and for the N-θ scattering amplitude, which obeys an exact effective range formula in the same local limit. The elementarity of the V-particle is discussed in relation with the Z = 0 rule and Levinson's theorem which is found wanting. The case of an unstable V-particle is also considered, and leads, for local coupling, to an exact Breit-Wigner formula for the N-θ scattering cross section. (auth)

17168 HOMOMORPHISMS AND DIRECT SUMS OF NESTED HILBERT SPACES. Grossmann, A. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Commun. Math. Phys., 4: 190-202(1967).

Some elementary facts about homomorphisms and infinite direct sums of nested Hilbert spaces are proved. (auth)

17169 FIELDS AT A POINT. Grossmann, A. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Commun. Math. Phys., 4: 203-16(1967).

Free fields and Wick products without smearing are studied as operators in a nested Hilbert space. It is shown that Wick products are entirely analytic in complex space-time and that products of field operators are holomorphic in the forward tube. The Poincaré group is represented by unitary automorphisms of the Fock space. (auth)

17170 LAGRANGIAN FORMALISM OF THE THEORY OF SPIN 2 FIELDS. Bhargava, S. C.; Watanabe, H. (Tokyo Univ.). Nucl. Phys., 87: 273-9(1966).

A Lagrangian formulation of the theory of spin 2 fields is proposed. From the Lagrangian which contains three arbitrary parameters α, α^* and δ, the field equation, subsidiary conditions and the condition of the symmetrical nature of the tensor field $\psi_{\mu\nu} = \psi_{\nu\mu}$ are derived. Covariant commutation relations for free fields are obtained. The result of introducing interaction with an electromagnetic field by gauge invariant replacement is discussed, and it is shown that the physical results do not depend on these parameters. (auth)

17171 CHILAR-SYMMETRIC PHOTON THEORY. Bakri, M. M. (Cairo Univ.). Nucl. Phys., 87: 289-305(1966).

The development of six- and eight-component photon theories is presented. The reduction to the different previous four-component theories is carried out. A unitary Foldy-Wouthuysen transformation is given for the six-component theory. The existence of non-commutative energy-momentum operators with correct expectation values is pointed out. These operators are used, together with the usual Pauli-Lubanski four-pseudo-vector, to develop the eight-component theory systematically, starting from four-vector and pseudo-vector potentials. The chilar symmetry of the Lorentz group is exploited to describe two types of photons with electromagnetic fields (E,H) and (E,−H) and positive energies; each has two states of polarization. Generalizing the Lorentz force in a chilar-symmetric way, it is found that the two fields cannot be distinguished experimentally in classical electrodynamics. (auth)

17172 USE OF CUTKOSKY RULES FOR FINDING THE ANALYTIC STRUCTURE OF THE FREE TWO-PARTICLE PROPAGATOR. Cordero, P.; Osborn, H.; Zienau, S. (London Univ.). Nucl. Phys., 87: 321-5(1966).

The Cutkosky rules for two-particle states are derived using the Thirring formula for the product of two Δ functions in a way which brings in a contribution from negative energy mass shell δ functions. (auth)

17173 PROPERTIES OF A CAUSAL GREEN'S FUNCTION FOR THE BETHE-SALPETER EQUATION. Keam, R. F. (Oxford Univ.). J. Math. Phys. (N. Y.), 7: 2196-2210(Dec. 1966).

The following properties of the free, but off-mass-shell, Bethe–Salpeter causal Green's function, for two spinless bosons whose masses may differ, are investigated: (a) its symmetries, (b) its expression in terms of the common higher transcendental functions, and (c) its forms in the asymptotic region and near the origin. An energy–spectral integral representation is also obtained. (auth)

17174 STRUCTURE OF INVARIANTS IN THE WAVE EQUATION OF n-DIMENSIONAL HARMONIC OSCILLATOR. Matsuo, Shigeru (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 44: 381-5(Sept. 1966).

The constants of motion of an n-dimensional harmonic oscillator are proved to satisfy the same commutation relations as those of infinitesimal generators of an n-dimensional unitary unimodular group. An extension of the considerations to the relativistic case results in the isomorphism of symmetry group of the system to the special complex Lorents group, and this fact will be used in the non-local theory of fields to connect internal and external quantum numbers of elementary particles. (auth)

17175 CAN CURRENT OPERATORS DETERMINE A COMPLETE THEORY? Langerholc, J.; Schroer, B. (Univ., Hamburg). Commun. Math. Phys., 4: 122-36(Jan. 12, 1967).

For the free field currents $j_\mu(x)$ in the sector of charge zero it is proven that one can reconstruct the bilocal fields $\phi(x)\bar{\phi}(y)$. (auth)

17176 COLLISION CROSS SECTIONS IN TERMS OF LOCAL OBSERVABLES. Araki, H.; Haag, R. (Univ. of Illinois, Urbana). Commun. Math. Phys., 4: 77-91(Jan. 12, 1967).

Asymptotic relations for matrix elements of quasilocal operators are given which generalize and extend the Lehmann-Symanzik-Zimmermann relations. These relations allow the simulation of a coincidence arrangement of particle detectors in the mathematical frame of the theory and thereby the expression of collision cross sections in terms of expectation values of observables. (auth)

17177 SPINOR AS AN INVARIABLE OBJECT. Zhelnorovich, V. A. Prikl. Mat. Mekh., 30: 1087-97(Nov. Dec. 1966). (In Russian).

A number of elementary particles can be described by wave functions representing a spinor in three- or four-dimensional space. Spinor equations can be written in the form of equivalent equations which can be considered in arbitrary, curvilinear systems of coordinates. It is shown how a spinor can be represented by a system of complex tensors, or by a system of real tensors. The algebraic relations between the real and complex tensors are also given. A two-component spinor in Minkowski space is shown to be equivalent to an antisymmetric tensor. The spinor in three-dimensional space can be considered as a particular case of a two-component spinor in four-dimensional space, and hence, the spinor in three-dimensional space is equivalent to an isotropic, complex pseudovector. Every spinor equation can be represented in an equivalent fashion by tensor components. A closed system of equations in tensor components can be obtained from the spinor equations. The tensor forms of the Dirac equations dealing with relativistic electron theory are presented. The equations for the neutrino are given in tensor form. The spinor representation is extended to the complete affine group of k-parameters with G coordinate transformations of n-dimensional Euclidean space. (TTT)

17178 A NOTE ON THE PCAC RELATION. Maki, Ziro; Umemura, Isao (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 1304-6(Dec. 1966).

The PCAC relation is studied. Assuming that all hadrons are the composites of the fundamental Dirac fields, relations for the meson (π) field are shown. (J.F.P.)

17179 ON THE SEPARATION OF REDUNDANT VARIABLES IN THE QUANTUM THEORY OF THE YANG–MILLS FIELD. Goto, Tetsuo (Nihon Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 1283-98(Dec. 1966).

Following close parallelism to the electrodynamics, the decomposition of the Yang-Mills Field is performed in the gauge invariant way. Thus, it is easily seen that gauge independent parts are transverse vector fields which are subjected to quantization. Elimination of redundant variables from the hamiltonian is also performed by a unitary transformation. The essential difference from the arguments of Schwinger and Arnowitt-Fickler is clarified. (auth)

17180 EQUIVALENCE OF THE LEE AND ZACHARIASEN MODELS. Osborn, H.; Zienau, S. (London Univ.). Nucl. Phys., B1: 180-2(1967).

The similarity existing between the Lee model and the Zachariasen model within the framework of perturbation theory is illustrated—both being the sum of an infinite series of self-energy bubble diagrams in the first nontrivial two-particle sector. Based on Weinberg's perturbation expansion of relativistic field theory, it is shown that the Lee model in the reference frame with infinite total momentum gives the same result for the scattering amplitude as the Zachariasen model. (L.B.S.)

17181 ABSENCE OF INTERACTION AS A CONSEQUENCE OF GOOD ULTRAVIOLET BEHAVIOR IN THE CASE OF A LOCAL FERMI FIELD. Powers, Robert T. (Princeton Univ., N. J.). Commun. Math. Phys., 4: 145-56(1967).

The ICAR theorem asserts that a local relativistic Fermi field is necessarily a free field, if it satisfies the canonical anticommutation relations, irreducibility of the fields at a fixed time, and certain regularity conditions. The regularity conditions are slightly stronger than the requirement that the mass renormalization be

finite. It follows that an interacting Fermi field must violate one or more assumptions of the ICAR theorem. (auth)

Scattering Theory

Refer also to abstract 17075.

17182 DETERMINATION OF THE HIGH-ENERGY ASYMPTOTICS OF AMPLITUDES FOR SCATTERING QUANTUM-MECHANICAL PARTICLES BY ENERGY-DEPENDENT POTENTIALS. Mal'chenko, V. I. Ukr. Mat. Zh., 19: 102-8(1967). (In Russian).

Spectral concepts of amplitudes of elementary particle scattering by energy dependent potentials were studied previously. An attempt was made to expand the studies by determining asymptotic properties of the quantum mechanics of the amplitudes of scattering at high energies. (R.V.J.)

17183 WIGWAM SINGULARITIES. Cunningham, J.; Rafique, M. (Univ. College of North Wales, Bangor). Nucl. Phys., B1: 21-34(1967).

A description is given of a method of obtaining both the Landau curves and their corresponding Feynman parameters wherein the internal four momenta of a Feynman graph are explicitly represented. The method is applied to the sixth order Wigwam diagram with the following results: a strict hierarchy of Landau curves based on equation plus Feynman parameter values does not exist in perturbation theory: a conjecture concerning effective intersections between Landau curves of adjacent orders is shown to be false. (auth)

17184 SOME GEOMETRICAL INTER-RELATIONSHIPS OF LANDAU CURVES. Cunningham, J.; Rafique, M. (Univ. College of North Wales, Bangor). Nucl. Phys., B1: 35-40(1967).

A catalog is given of certain first and second type vertex Landau curves and their tangency properties investigated. Coincidences between differing orders and differing types of Landau curve are shown to be commonplace. (auth)

17185 QUASI-FREE SCATTERING. Berggren, Tore (Lund Inst. of Tech., Sweden); Tyren, Helge. Annu. Rev. Nucl. Sci., 16: 153-82(1966).

The discussion of quasi-free scattering includes a brief history and treatment, problems involved in quasi-free scattering experiments, dependence on nuclear structure, and on the reaction mechanism, and observation of inner shells. Current trends in the field of quasi-free scattering on single protons in nuclei are indicated. (J.F.P.)

17186 REGGE POLES. Omnes, Roland L. (Centre de Recherches Nucleaires, Strasbourg). Annu. Rev. Nucl. Sci., 16: 263-90(1966).

Nonrelativistic theory is covered including the Schroedinger equation for complex angular momenta, asymptotic behavior in $\cos\theta$, the effect of an exchange potential, and the case of particles with spin. Extensions and limitations are discussed, the topics being nonrelativistic problems, factorization of residues, scattering of a potential on a bound state, three-particle scattering, relativistic complex momenta, trajectories, and Regge poles for the Mandelstam hypothesis, perturbation theory, and elementary particles. Also comparison is made with experiment. (J.F.P.)

17187 HERMITIAN ANALYTICITY AND S-MATRIX SINGULARITY STRUCTURE. Polkinghorne, J. C. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 7: 2230-4(Dec. 1966).

It is shown that the requirement of Hermitian analyticity can be used to determine the Riemann sheet structure of S-matrix singularities. The examples of the square-diagram Landau curve and of a single anomalous threshold are discussed for the $(2 \rightarrow 2)$-particle amplitude. (auth)

17188 PERATIZATION OF THE LOGARITHMICALLY SINGULAR POTENTIAL. Gale, William A. (Rice Univ., Houston, Tex.). J. Math. Phys. (N. Y.), 7: 2171-3(Dec. 1966).

The potential of the form $(gr^{-4} \ln^2 r - g^{\frac{1}{2}}r^{-3})\vartheta(r - r_0)$ is shown explicitly to be regularizable by an infinitesimal cutoff. It is also shown that, when a modified sense of the peratization technique is applied to the regulated scattering length, the correct answer is regained. (auth)

17189 ON THE POSSIBILITY OF THE EXPERIMENTAL INVESTIGATIONS OF MANDELSTAM CUTS. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 197-200(Jan. 1967). (In Russian).

Experiments are discussed, making it possible to clarify the role of Mandelstam cuts in the angular momentum plane, in high energy scattering processes. (auth)

17190 ASYMPTOTIC APPROXIMATIONS OF PHASE SHIFTS. Michalik, B. (Inst. of Plasma Physics, Prague). Nuovo Cimento (10), 47B: 194-9(Feb. 11, 1967).

Two approximations of phase shifts, one of them being new, are extracted from the asymptotic expressions of wave function. For the sake of simplicity only spherically symmetric potentials are considered. The two approximate phase shifts are compared with each other and with the exact phase shift for the case of potential wells and barriers for s- and p-waves. (auth)

17191 TWO-MESON SOLUTION OF THE CHARGED SCALAR STATIC MODEL WITH BOUND STATES. Bronzan, J. B. (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys. (N. Y.), 8: 6-12(Jan. 1967). (MIT-2098-233).

A two-meson solution of the charged scalar static model is constructed for the case in which the coupling is sufficient to produce bound states. This is done by taking the solution given previously for the case in which bound states are absent and increasing the coupling. As usual, bound states appear as poles in scattering amplitudes. However, since one of the mesons in the three-body states can bind to the source, bound-state meson scattering channels also appear. The new amplitudes relating to bound-state meson scattering are obtained, and their unphysical singularities are examined. The enlarged scattering matrix is unitary. (auth)

17192 ROLE OF THE INTEGRAL-OPERATOR METHOD IN THE THEORY OF POTENTIAL SCATTERING. Gilbert, R. P. (Indiana Univ., Bloomington); Howard, H. C. J. Math. Phys. (N. Y.), 8: 141-8(Jan. 1967).

A recently developed method in the theory of potential scattering is investigated. Analytic computations for determining the location and the type of singularities, which occur in several scattering amplitudes that are constructed from physically relevant potentials are supplied. (auth)

17193 ANALYTIC S-MATRIX. Eden, R. J.; Landshoff, P. V.; Olive, D. I.; Polkinghorne, J. C. New York, Cambridge University Press, 1966. 293p. $14.00.

This book is devoted to the development of a theory of the S-matrix from physically plausible assumptions and investigations of its mathematical consequences. Chapter 1 is intended to introduce in an elementary way various notions which constitute a background to what follows. Chapter 2 develops the analytic properties of Feynman integrals. The Landau equations and Cutkosky discontinuity formula are ideas encountered which prove more general than their perturbation theory origin. Chapter 3 discusses asymptotic behavior. Chapter 4 is concerned with investigations of the properties of the analytic S-matrix. (L.B.S.)

Particle Accelerators

Refer also to abstracts 16126, 16897, 17318, and 17413.

17194 (AED-C-18-07) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 18: Accelerators. Mausberg, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Nov. 1966. 122p. Dep. mn.

A bibliography of 432 references on various aspects of particle accelerators is presented. Included also are author, patent, report number, and subject indexes. (B.G.D.)

17195 (AED-C-18-09) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. Sektion 18: Beschleuniger. (Bibliographies in Nuclear Science and Technology. Section 18: Accelerators). Mausberg, W. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec. 1966. 106p. (In English and German). Dep. mn.

A bibliography of 390 references on various aspects of particle accelerators is presented. Included also are author, patent, report number, and subject indexes. (B.G.D.)

17196 (BNL-11081) MICROWAVE SYSTEMS FOR SUPERCONDUCTING RF SEPARATORS. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). June 17, 1966. Contract AT(30-2)-Gen-16. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A microwave system for superconducting rf separators is described which can be used either in cw operation or on a long pulse length basis with only minor modifications within the servo loops. Since the power required by the cryogenic equipment will be proportional to unloaded $Q(Q_0)$ and the duty factor, a pulsed operation would be more economical. This is especially true if the final Q_0 is lower than expected. The lowest duty factor achievable depends on the desired pulse length, the time required to stabilize the phase and the filling time τ of the deflector. $\tau = Q_L/\omega$ and $Q_L = Q_0/(1 + \varkappa)$

where $\varkappa$ = coupling coefficient. In a superconducting structure $\varkappa$ can be made $\gg 1$, the only limitation being the rf power that can be afforded to waste. Assuming a 200 millisecond pulse every 2.5 sec, one can easily operate the system at 30% duty factor. (B.G.D.)

17197 (BNL-11100) EXPERIMENTS IN COMPUTER CONTROL AND ANALYSIS OF THE AGS. Frankel, R. (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 2p. (CONF-670307-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The development, design, and test of computer input/output devices and programing techniques suitable for use in accelerator analysis and control as well as criteria for the selection of computers acceptable for analysis and control work are described. (auth)

17198 (BNL-11102) BEAM EXTRACTION FROM THE PROTON SYNCHROTRON. Barton, M. Q. (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 11p. (CONF-670307-8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A review is given of the fast beam extraction systems developed for the Brookhaven and CERN machines. The use of the third integral resonance in the slow extraction system being developed at Brookhaven is described and compared with the slow extraction system at CERN. The future of external beams for AG proton synchrotrons and considerations for the 200 GeV machines are discussed. (L.B.S.)

17199 (BNL-11109) SAND AS A SIDE SHIELD FOR 30 GeV PROTONS STOPPING IN THE BROOKHAVEN AGS. Casey, R.; Distenfeld, C. H.; Levine, G. S.; Moore, W. H.; Smith, L. W. (Brookhaven National Lab., Upton, N. Y.). Nov. 9, 1966. Contract AT(30-2)-Gen-16. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements of the side shielding characteristics of the sand cover over the AGS ring are discussed and the results were found to be consistent with published interaction lengths for strongly interacting particles. Marginal evidence of a weakly interacting tail beyond 20 ft was found. It is emphasized that the energy spectrum and components of the particle population are not well known. (L.B.S.)

17200 (BNL-11111) SINGLE PULSE TRANSVERSE PHASE SPACE BEAM ANALYSER. Sluyters, Th. J. M.; Damm, R.; Otis, A. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 11p. (CONF-670307-13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

A device is described with which total and partial horizontal or vertical emittances can be measured in shorter than 40 μs. (auth)

17201 (BNL-11117) PROTON SYNCHROTRONS FOR ENERGIES ABOVE 20 GeV. Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 4p. (CONF-670307-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Some details are presented of the CERN 28-GeV PS and the Brookhaven 33-GeV AGS improvement programs, which are aimed at increasing both the peak and average beam intensities and at adding to the experimental capabilities of both machines. Super-energy efforts involved in the design and construction of new accelerators are also discussed. Most advanced is the 70-GeV synchrotron at Serpukhov in the USSR. Also under construction in the USSR is a 25-GeV proton–antiproton storage ring. Design studies have reached a relatively complete preliminary stage for a 40-GeV machine in Japan, a 45-GeV accelerator in France, and for the American 200-GeV and European 300-GeV synchrotrons. Prospects for the development of super accelerators above 600 GeV in the distant future are briefly discussed. (L.B.S.)

17202 (BNL-11141) STUDIES OF BEAM BEHAVIOR IN THE ENERGY REGION OF 50 TO 400 MeV WITH THE BROOKHAVEN ALTERNATING GRADIENT SYNCHROTRON. van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT(30-2)-Gen-16. 12p. (CONF-670307-21). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The "fast kicker" of the Brookhaven AGS, normally used for orbit perturbation at high energy as part of the fast ejected beam system is used to eject the circulating proton beam in the energy region of 50–400 MeV. Beam behavior in the early part of the acceleration cycle is studied by measuring the ejected beam vertical phase space emittance and density distribution. Effective phase space dilution and beam intensity dependent effects have been observed. The observed distributions are consistent with a four or six dimensional gaussian distribution. (auth)

17203 (BNL-11169) IMPROVED CALCULATIONS OF PROPERTIES OF THE SLOW EXTRACTED BEAM. Barton, M. Q.; Faure, J. (Brookhaven National Lab., Upton, N. Y.). Feb. 3, 1967. Contract AT(30-2)-Gen-16. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Using the CDC 6600 version of BEAM, improved calculations were made for slow beam extraction from the AGS starting with a procedure for finding unstable fixed points and then following unstable trajectories through the system, ejector, and even the fringing field until the trajectories are completely free of the accelerator. A description is given of the mathematical method, followed by a discussion of the results. It is concluded that the calculations confirm the preliminary estimates used to establish design parameters for the hardware constructed for the beam. Some future developments are mentioned. (L.B.S.)

17204 (CONF-660918–, pp 236-44) APPLICATIONS OF RF SUPERCONDUCTIVITY TO ACCELERATORS AND INSTRUMENTATION. Wilson, P. B.; Fairbank, W. M.; Schwettman, H. A.; Smith, T. I.; Turneaure, J. P. (Stanford Univ., Calif. High-Energy Physics Lab. Stanford Univ., Calif. Dept. of Physics).

Basic information on the direct use of superconducting rf devices and a brief discussion of the specific application to electron linacs and rf separators are presented. (B.G.D.)

17205 (CONF-660918–, pp 260-1) CONSIDERATIONS FOR SUPERCONDUCTING RF PARTICLE SEPARATORS. Juengst, W. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik. Kernforschungszentrum, Karlsruhe (West Germany)).

The features of superconducting rf separators are investigated and the method used to find favorable parameters is described. Such separators are thought to extend the momentum range of electrostatic separators toward higher momenta when long operation is required. The main interest is therefore concentrated on the Panofsky type, consisting of two cavities, each of length L, with an intermediate drift space D. Montague's idea of intercepting the unwanted particles by means of a central beam stopper are adopted and K, π-separation in the numerical examples are assumed. (auth)

17206 (CONF-660918–, pp 262-3) FIELDS OWING TO CURRENTS IN Nb_3–Sn IN QUADRUPOLE LENSES. Kruger, P. Gerald (Brookhaven National Lab., Upton, N. Y. Illinois Univ., Urbana. Dept. of Physics); Sampson, W. B.; Britton, R. B. (Brookhaven National Lab., Upton, N. Y.); Snyder, J. N. (Illinois Univ., Urbana. Dept. of Computer Science).

The development of superconducting quadrupole lenses using current sheets of Nb_3–Sn is discussed. (B.G.D.)

17207 (CONF-660918–, pp 296-8) COMPUTER SYSTEMS FOR DATA ANALYSIS. Miller, W. F. (Stanford Linear Accelerator Center, Stanford Univ., Calif.).

Three of the computer systems for data analysis at SLAC in various stages of development are discussed. These are: Beam Switchyard (BSY) Control System, Spectrometer Data Acquisition and Analysis System, and the CRT digitizer HUMMINGBIRD and GOONEYBIRD. (B.G.D.)

17208 (LA-3673) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1967. (Los Alamos Scientific Lab., N. Mex.). Feb. 1967. Contract W-7405-eng-36. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The status of developments in accelerator structures, of power sources, accelerator control and instrumentation, accelerator physics, and project scheduling and facilities planning for the period ending Jan. 31, 1967 is discussed. (L.B.S.)

17209 (LA-DC-8344) FAST AUTOMATIC PHASE AND AMPLITUDE CONTROL OF HIGH-POWER RF SYSTEMS. Jameson, Robert A.; Hoffert, William J. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 12p. (CONF-670307-18). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Recent progress in the design and testing of the fast feedback rf control system being developed for the Los Alamos Meson Physics Facility (LAMPF) proton linac is reviewed. Closed-loop rf phase control with correction bandwidths greater than 200 kHz is demonstrated using a coaxitron power amplifier driving a full-scale ac-

celerator structure. Proposed experimental studies to determine control characteristics, synthesize closed-loop amplitude control systems, and study phase-amplitude interactions in 1.25-MW, 6% duty factor klystron, triode, and crossed-field amplifier systems are outlined. Extremely phase-stable frequency sources have been developed to supply reference signals at 201.25 MHz and 805 MHz. The design and testing techniques used to verify phase stability and mutual coherence of the harmonically related outputs are summarized. (auth)

17210 (LA-DC-8370) CROSSING HIGH-VOLTAGE INTERFACES WITH LARGE BANDWIDTH SIGNALS. Severns, Rudolf P.; Turner, Thomas F.; Koelle, Alfred R. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 14p. (CONF-670307-20). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

In connection with a 50-kV modulator development, three methods of crossing the high-voltage interfaces at a 1-MHz bandwidth are being developed. The first system uses a pulse transformer driven from ground by solid-state electronics. The second system is an amplitude-modulated rf carrier operating at 5 MHz. The third method uses a Hewlett-Packard HPA-4309 electro-optical isolator with solid-state amplifier on the high-voltage side. A description is given of experiment and results with each method. (L.B.S.)

17211 (LA-DC-8598) PHYSICS WITH MESON FACTORIES. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 53p. (CONF-670207-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 2nd International Conference on High Energy Physics and Nuclear Structure, Rehovoth, Israel.

The characteristics of a typical meson factory are indicated using as a reference the LASL machine. A number of the more important uses of a meson factory for basic physics are discussed in some detail including studies of nuclear forces, nuclear structure, nuclear structure studies with mesons (μ), weak interactions, fundamental particle studies, and electromagnetic interactions. (J.F.P.)

17212 (LAL-1167) RAPPORT D'ACTIVITE DU GROUPE DE L'ANNEAU DE COLLISIONS D'ORSAY, 15 AVRIL 1966-15 OCTOBRE 1966. (Report of Activity of the Orsay Collision-Ring Group, April 15-October 15, 1966). (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jan. 1967. 18p. (In French). Dep. mn.

Studies on fast injection and the study on the structure and stability of electron beams of several tens of mamp constituted the essential part of the experimental program on the ACO ring. Results were obtained on the current collected by the sweep electrodes or by electrostatic beam separation electrodes. Theoretical studies were made on linear coupling, non-linear betatron oscillations, coherent phase oscillations, and injection in the ACO. The conditions for the utilization of various monitoring reactions were defined more precisely. Most of the results obtained were published at the Symposium International sur les Anneaux de Collisions à Electrons and Positrons, which was held at Saclay, September 26-30, 1966. (J.S.R.)

17213 (SLAC-68) INSTRUMENTATION, COMPUTER CONTROL, AND ELECTRONIC SYSTEMS FOR THE SLAC BEAM SWITCHYARD. Neet, D. A. G. (ed.) (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Oct. 1966. Contract AT(04-3)-400. 130p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Functional descriptions are given of various switchyard systems. Information of a more general nature is also included. Topics discussed include instrumentation for the beam switchyard; general design considerations; beam current monitoring; beam position monitoring; beam profile monitoring; secondary emission foil monitors; beam spectrum instrumentation; magnetic measurement instruments; controls for magnets, slits, and collimators; computer system; equipment protection in the switchyard; and beam switchyard control room. (L.B.S.)

17214 (SLAC-69) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, April 1-June 30, 1966. (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Dec. 1966. Contracts AT(04-3)-400; AT(04-3)-515. 93p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress on the two-mile Stanford linear accelerator project is reported for the period April 1, 1966 to June 30, 1966. Topics include plant engineering, systems engineering, accelerator physics, instrumentation and control, heavy electronics, mechanical design and fabrication, klystron studies, accelerator operations, beam switchyard, research area operations, and pre-operation research and development. (B.G.D.)

17215 (SLAC-PUB-248) CONCISE ON LINE CONTROL SYSTEM. Howry, Sam (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Oct. 1966. Contract AT(04-3)-515. 13p. (CONF-670403-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Joint Computer Conference, Atlantic City, N. J.

A small on-line computer system was developed at SLAC to monitor and control magnets and other equipment leading from the accelerator to the experimental areas. (B.G.D.)

17216 (UCRL-17223) BEVATRON OPERATION AND DEVELOPMENT. 50. APRIL-JUNE 1966. Brokloff, Robert W.; Crebbin, Kenneth C. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 17, 1966. Contract W-7405-eng-48. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The beam was on for experimenters 85.7% of the scheduled operating time. During this quarter, the Bevatron accelerated 1.80×10^{18} protons. The external-proton-beam extraction efficiency for short spills (200 to 500 μsec) was doubled (from 15% to 30%) by using an outer-radius lipless target. It was found that the cranes above the Bevatron magnet caused a local perturbation in the magnetic field near peak field. This perturbation was sufficient to cause tracking changes and beam loss in some modes of operation. (auth)

17217 (UCRL-17224) BEVATRON OPERATION AND DEVELOPMENT. 51. JULY-SEPTEMBER 1966. Allison, Robert W.; Crebbin, Kenneth C. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1, 1966. Contract W-7405-eng-48. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The beam was on for experimenters 89% of the scheduled operating time. During this quarter, the Bevatron accelerated 2.26×10^{18} protons. The craneway and building frame were installed this quarter for a new external-proton-beam experimental hall. Four different modes of magnet pulsing were used this quarter including the new "mezzanine" mode of operation. There were two scheduled shutdowns, primarily for routine inspection of the main motor-generator journals and bearings. A vacuum gasket on a Bevatron vacuum-tank port that had been damaged by radiation was replaced and the vacuum port redesigned to minimize future damage to the gasket. Initial tests were conducted on computer control of the Bevatron inflector system. (auth)

17218 (UCRL-70205) REVIEW OF DYNAMIC INSTABILITIES IN CIRCULAR ACCELERATORS. Neil, V. Kelvin (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 15, 1967. Contract W-7405-eng-48. 8p. (CONF-670307-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The coherent electromagnetic self-forces of a beam of particles in an accelerator can render unstable the motion of individual particles, or give rise to unstable coherent motion of the beam. Coherent longitudinal bunching of an azimuthally uniform beam can result from the negative mass instability or interaction of the beam with the accelerating cavities. The negative mass instability can be suppressed by a sufficient spread in circulation frequency or by surrounding the beam with appropriate walls. The beam-cavity interaction can be overcome by careful design of the rf system. The interaction of the self-fields with the surrounding walls can lead to unstable coherent transverse motion through the finite resistance of the wall material. This instability may be suppressed by a sufficient spread in betatron frequencies. The relatively slow growth rate also allows stabilization by means of electronic feedback, and the stabilizing effect of passive structures has also been investigated. Experimental and theoretical investigation has led to an understanding of these effects to the extent that accelerators can be designed to overcome the instabilities. (auth)

17219 (UJV-1640) ENERGY VARIATION OF THE ^{120}U CYCLOTRON. Dobias, J.; Fukatko, T.; Hrda, A.; Karban, O.; Krivanek, M.; Kult, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 21p. Dep. mn.

The possibility of varying the energy of the U-120 type cyclotron without any additional corrections of the radial gradient of the magnetic field was examined experimentally. The shims were left as they were adjusted formerly for $B_0 = 1.45$ Wb/m^2. The energy of the external deuterons beam was measured by means of semiconductor detectors. It was found that the energy of the external beam can be varied in the range from 12.4 to 14.5 MeV, the corresponding beam intensities are sufficient for most nuclear reaction studies. (auth)

17220 (USNRDL-TR-67-5) THE OPTIMIZATION OF THE CENTRAL REGION ELECTRIC FIELD FOR THE NRDL CYCLOTRON. Reiser, M. P. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 28, 1966. 37p.

Results of studies of the central region accelerating system employing the UCLA type dees-in-the-valleys are presented. It is shown that a 90° dee tip in conjunction with an adjustable puller best satisfies the requirements of a variable energy, multi-particle, isochronous cyclotron. The results of computer calculation for programmed orbits show that this geometry yields good orbit centering and satisfactory radial beam quality. The base width of the acceptable ion beam in the first harmonic mode is about 60° at the start and broadens to 90° during subsequent acceleration. In the third harmonic mode, on the other hand, the phase width is 30° initially and subsequently contracts to 25°. Orbit details, positions of the source, puller, and defining slits are also described. (auth)

17221 POWER-SUPPLY PLANTS FOR MAGNETS IN CIRCULAR ACCELERATORS. Stirba, A. (Siemens Aktiengesellschaft, Erlangen, Ger.). Kerntechnik, 9: 24-6(Jan. 1967). (In German).

For the power supply of beam-guide magnets in circular accelerators very high outputs are required with defined pulse programs. To reduce the load peaks and utilize the energy liberated on the cycle de-excitation of the magnets, an energy storing system is provided. In the case of proton accelerators, which generally operate at a low pulse frequency, the flywheel mass of a motor-generator set acts as the energy storing device. For the much higher pulse frequency of electron accelerators, resonant circuit formed by capacitors and reactance coils serve to store the energy. Both designs of power plant are described. (auth)

17222 ACCELERATING SYSTEM AND THE HIGH-FREQUENCY GENERATOR OF THE JUELICH RELATIVISTIC ISOCHRONOUS CYCLOTRON. Kannowade, H. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Kerntechnik, 9: 21-4(Jan. 1967). (In German).

The working frequency of the acceleration system of the Jülich isochronous cyclotron is equal to the third harmonic of the particle revolution frequency. It consists of three quarter-wave resonators located within the magnet in regions with a wide air gap. The resonant frequency of the system may be adjusted continuously between 20.7 and 29.6 MHz by capacitive balancing. For calculation purposes, the individual sectors are taken as inhomogeneous circuits whose characteristic impedance quantities obtained from model measurements on resistance paper, or purely numerically. The single-stage hf generator is self-excited, with a 70 kW output. The plate is grounded and thus carries no dc voltage. The generator is mounted on top of the magnet yoke and is connected with the accelerating system by a concentric line which is also used for voltage step-up. (auth)

17223 RADIOFREQUENCY PLANT OF THE KARLSRUHE RELATIVISTIC ISOCHRONOUS CYCLOTRON. Feldmann, H. H.; Riller, P.; Eyber, H. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Kerntechnik, 9: 17-20(Jan. 1967). (In German).

After a general introduction, all units of the radiofrequency plant are described: The principle of feedback and of the tank circuit of the main oscillator and its technical design are discussed and illustrated by several figures. Some remarks on the multipactoring effect are followed by the description of the booster oscillator. The power-supply is treated, and at last there are detailed data on the control circuits for the amplitude [40 kV($1 \pm 1 \times 10^{-3}$)] and the frequency [33 MHz($1 \pm 1 \times 10^{-5}$)] of the rf voltage. (auth)

17224 VARIOUS PROBLEMS OF MAGNET FABRICATION FOR HIGH-ENERGY ACCELERATORS. Appun, J. (Siemens Aktiengesellschaft, Berlin). Kerntechnik, 9: 10-16(Jan. 1967). (In German).

The manufacture of magnets for high-energy accelerators implies problems which cannot be solved by usual means and customary production processes. This is due to the high degree of precision demanded for workpieces with relatively large dimensions and weights, to the necessity of small tolerances which lie near the limit of technical possibilities, and to an extraordinary equability in fabrication. These demands do not only concern the geometrical dimensions but also the magnetic properties and other physical and electrical quantities. The problems are dealt with in detail, and the necessary procedures are discussed and illustrated by examples from built installations. The examples refer to magnets with blocks of laminated steel and with water-cooled exciting coils of strands conductors, e.g., for synchrotron magnets for beam guidance in a circular accelerator, and also to magnets with a yoke of solid steel and with coils of hollow water-cooled copper conductors, e.g., for bending and focussing magnets. Superconducting magnets are mentioned as a new development. (auth)

17225 SERIES OF DC POWER-SUPPLY UNITS OF HIGH AND VERY HIGH CONSTANCY AT LARGE OUTPUTS. Palme, K. (Siemens Aktiengesellschaft, Erlangen, Ger.). Kerntechnik, 9: 33-5(Jan. 1967). (In German).

Dc power-supply units incorporating transistors as the final control element have very highly stabilized output quantities. Previously, however, they were only built for small outputs. The units described here provide a means of combining high outputs with high accuracies of 10^{-4} and 10^{-5}. (auth)

17226 POWER SUPPLY OF DEFLECTING AND FOCUSSING MAGNETS WITH HIGHLY STABILIZED DIRECT CURRENT. Berger, G. (Siemens Aktiengesellschaft, Erlangen, Ger.). Kerntechnik, 9: 27-30(Jan. 1967). (In German).

The power supply for deflecting and focusing magnets required in accelerators to guide the particle beam onto the test objects is provided by motor-generator sets and also, to an ever increasing scale, by semiconductor convertor plants. It must be possible to adjust the magnet currents within a wide range and to keep them constant by 0.01% by means of a current control system. A thyristor convertor unit is described with highly accurate current control built for CERN. Numerous facilities for reconnection permit the output values to be varied to suit a wide range of magnet types. A description is also given of a new current control system for the motor-generator sets of the Experimental Hall East for the CERN 28-GeV proton synchrotron. This has made it possible to increase the stability of the current from ±0.1% to 0.01%. (auth)

17227 PROTON STORAGE RINGS OF CERN. Hiesinger, L. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Kerntechnik, 9: 30-3(Jan. 1967). (In German).

The idea and purpose of the CERN project already under construction is discussed. The improved performance of the 28-GeV proton synchrotron extended by intersecting storage rings allows interactions between protons corresponding to an energy up to 1.5 TeV of the classical accelerator using hydrogen targets at rest. A new region of subnuclear physics will then become accessible by experiments. CERN's scientists and engineers have designed and specified a machine the realization of which demands from European industry to comply with the special requirements as to close tolerances and excellent workmanship. (auth)

17228 SECONDARY PARTICLE YIELDS AT 0^0 FROM THE NEW STANFORD ELECTRON ACCELERATOR. Barna, A.; Cox, J.; Martin, F.; Perl, M. L.; Tan, T. H.; Toner, W. T.; Zipf, T. F.; Bellamy, E. H. (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 360-2(Mar. 6, 1967).

The yields of secondary particles produced at zero degrees to the direction of the incident beam in a beryllium target bombarded by 16-GeV/c electrons from the Stanford linear electron accelerator were measured. It was concluded that the secondary particle flux at zero degrees is within a factor of 2, the maximum obtainable at the Stanford Linear Accelerator Center and that secondary beams at zero degrees from targets can be used at this accelerator because the electrons or positrons can be removed without seriously affecting the secondary beam quality. (J.F.P.)

17229 SMALL-ANGLE PION FLUX PRODUCED IN A THICK BERYLLIUM TARGET BY HIGH-ENERGY ELECTRONS. Boyarski, A.; Bulos, F.; Busza, W.; Coward, D.; Diebold, R.; Litt, J.; Minten, A.; Richter, B.; Taylor, R. (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 363-5(Mar. 6, 1967). (SLAC-PUB-260).

The pion yield produced by 16-GeV electrons in a 0.6-radiation-length beryllium target was studied at laboratory angles of 0.2 to 1.1°. The experimental yields are somewhat larger than those estimated using the Drell and ρ-diffraction models for pion photoproduction, and they do not appear to decrease at small angles as expected from the theoretical models. (auth)

17230 PARTICLE YIELDS AT THE STANFORD TWO-MILE ELECTRON ACCELERATOR. Flatte, Stanley M. (Univ. of California, Berkeley); Gearhart, Roger A.; Hauser, Todd; Murray, Joseph J.; Morgado, R.; Peters, M.; Klein, P. R.; Johnston, L. H.; Wojcicki, Stanley G. Phys. Rev. Lett., 18: 366-9(Mar. 6, 1967).

The $\pi^{\pm}$, $K^{\pm}$, and $e^{\pm}$ yields at 2 and 3° from 16- and 18-GeV electrons on a 0.3-radiation-length beryllium target were measured at the Stanford two-mile electron accelerator. (auth)

17231 TARGET PREPARATION BY ION RETARDING METHOD. Chida, Katsuhisa; Kaneko, Kumetaro (Tokyo Univ.). Shitsuryo Bunseki, 14: 149-56(Oct. 1966). (In Japanese).

Studies of direct deposition of decelerated ions from an isotope separator on thin foils were reported. Fundamental behavior of decelerated ions was investigated by measurement of ion currents to various electrodes placed in the collector part. A magnetic field of 1000 gauss produced by a permanent magnet was set in the place of decelerating electric field, so that one can measure the ion current without electron contamination and avoid accelerated electrons from bombarding the target. The attachment ef-

ficiency was studied as a function of final energy of ions, backing materials and their thickness. From these studies, optimum working conditions for obtaining good deposition were obtained. The ion beam used in the present experiments was that of ^{24}Mg and the backing materials were Au, Cu, Ni and Ta foils. As examples, ^{24}Mg with a thickness of 500 $\mu g/cm^2$ was obtained on a Au foil of 5 μ thickness with a current density of 30 $\mu A/cm^2$ and ^{24}Mg with a thickness of 300 $\mu g/cm^2$ was obtained on a Au foil of 0.5 μ thickness with a current density of 20 $\mu A/cm^2$. (auth)

17232 CHARACTERISTICS OF PHOTOIONIZATION PLASMA SOURCE. Hyman, Julius Jr.; MacKenzie, K. R. (Univ. of California, Los Angeles). Rev. Sci. Instrum., 38: 251-2(Feb. 1967).

A new plasma source is described. A collimated beam of photons of 6 μsec duration generates a plasma by single quantum photoionization of a rarefied gas. A uniform plasma column with sharply defined initial boundaries is produced remote from the container walls and in the absence of currents or fields. At 90 cm from the photon source, plasma densities of 10^{10} cm^3 are produced in argon at a pressure of 5 μ. (auth)

17233 MULTIPLE GAS SELECTOR SYSTEM FOR ACCELERATOR ION SOURCE. Evans, Albert E.; Simons, Donald G.; Brown, Bernard (Naval Ordnance Lab., Silver Spring, Md.). Rev. Sci. Instrum., 38: 228-9(Feb. 1967).

A means is described for remotely selecting one of four sources of gas for an rf ion source. The system consists of a specially designed five way ball valve connecting one of the gas sources to the ion source via a mechanical leak assembly. Provision is made for feedline roughout during source switchover. (auth)

17234 NEW SHUNT-SERIES NANOSECOND PULSE AMPLIFIER. Millard, J. K. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 38: 169-75(Feb. 1967). (ORNL-P-2582).

A new shunt-series amplifier section was developed for fast rise time pulse amplifiers intended primarily for use with accelerator beam probes, solid state detectors, and fast ionization chambers. Design equations for the gain section were derived from a high frequency model and were validated by computer analysis and experimental results. Two amplifiers were built, with three gain sections cascaded in each. The gain of these amplifiers was 270 and 135, and the rise time was 1 and 0.9 nsec, respectively. (auth)

17235 VACUUM PROBLEMS IN PARTICLE ACCELERATORS. Schryber, Urs (Eidgenoessische Technische Hochschule, Zurich). Schweiz. Arch. Angew. Wiss. Tech., 32: 287-91(Sept. 1966). (In German).

The vacuum problems found in high intensity particle accelerators are briefly indicated. The maintenance of high voltages in a vacuum is considered. The three types of discharges that can occur in a high vacuum are described. The mass spectra of the residual gases in accelerator cavities with and without a high voltage feed are illustrated. The scattering processes with charge exchange are considered with particular reference to the H_2 molecule. The CERN storage ring project is briefly considered. (J.S.R.)

17236 PREPARATION OF THIN FILM DEUTERATED POLYETHYLENE TARGETS. Tripard, G. E.; White, B. L. (Univ. of British Columbia, Vancouver). Rev. Sci. Instrum., 38: 435-6(Mar. 1967).

The preparation of thin film deuterated polyethylene targets capable of withstanding an incident 2-MeV deuteron beam of 200 nA through a 0.318 cm diam collimator for 1 hr with only a 10% deterioration of the deuterated polyethylene is discussed. (B.G.D.)

17237 PARTICLE-BEAM PROFILING SYSTEM. Gilmer, Robert E.; Neu, Franklin D.; Sprakfa, Robert J.; Strople, Joseph E. (Univ. of California, Berkeley). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 375-6(Mar. 1967). (UCRL-17213).

A system using a 25.4 cm square wire spark chamber with acoustic readout and storage oscilloscope to display a particle-beam profile is described. The instrument was built for an experiment at the Stanford Linear Accelerator Center. (auth)

17238 MESONIC ATOMS AND MOLECULES IN CHEMISTRY AND PHYSICS. Nilsson, Sam (Ingeloers Vetenskaps Akademien, Stockholm). Svensk. Kem. Tidskr., 78: 633-43(1966).

Studies with π mesons and muons are reviewed, and production and handling of π and μ beams from accelerators are described. A description is also given of studies of mesonic atoms and molecules, and, particularly, experiments of chemical interest. A discussion is provided on the basis of differences between the systems $(pep)^+$ and $(pup)^+$. Some speculations about future experiments with very intense beams of μ particles are presented. Many processes could be studied in detail if the intensities of muons were high. This will be realized with intermediate-energy accelerators which are to be built. The muon intensities will then be increased by 1000 fold. This may make it possible to study the van der Waals potential in detail. (BBB)

17239 DESIGN OF THE SHAPE ON THE LOW-FIELD SIDE OF THE MAGNET POLE FOR A STRONG-FOCUSING SYNCHROTRON. Doke, Tadayoshi (Tokyo Univ.); Kihara, Motohiro; Takeda, Minoru. Jap. J. Appl. Phys., 6: 403-7(Mar. 1967).

In order to obtain an economical design of the strong-focusing synchrotron magnet, the pole shape on the low field side is systematically investigated by the aid of a resistance network analog. The results show that there exists an optimum condition of minimizing the low field side margin for a simple pole shape. The application to the practical cases is discussed. (auth)

17240 ACCELERATING FIELD FOCUSING AND PHASE OSCILLATIONS. Mal'tsev, A. P.; Zotova, E. A.; Teplyakov, V. A. Prib. Tekh. Eksp., No. 6, 17-19(Nov.-Dec. 1966). (In Russian).

It is shown that phase oscillations improve the transverse stability in field focusing accelerators. Experiments using an electron model of a linear proton accelerator with field focusing showed the efficiency and simplicity of the installation. (tr-auth)

17241 UNIVERSAL INJECTOR FOR NEGATIVE IONS OF HYDROGEN ISOTOPES FOR CHARGE-EXCHANGE GENERATOR. Khirnyi, Yu. M.; Kochemasova, L. N. Prib. Tekh. Eksp., No. 6, 32-6(Nov.-Dec. 1966). (In Russian).

An injector was designed for negative (T_1^-, D_1^-, and H_1^-) produced by the charge exchange of positive ion, in a supersonic mercury vapor jet, using a hf source with water-cooled converter. The source was supplied with a mixture of 5% T + 95% He in order to develop positive tritium ions. The injector produced ion beams of T_2^- ~ 12 to 15μA, D_1^- ~ 20 μA, and H_1^- ~ 25 μA. (tr-auth)

17242 COMPACT DUOPLASMATRON NEGATIVE ION SOURCE FOR CHARGE-EXCHANGE GENERATORS. Almazov, A. V.; Khirnyi, Yu. M.; Kochemasova, L. N. Prib. Tekh. Eksp., No. 6, 36-9(Nov.-Dec. 1966). (In Russian).

A duoplasmatron with a constant magnet is described. The source produces an H_1^- ion current up to 140 μA. (tr-auth)

17243 ON-LINE COMPUTER TECHNIQUES IN NUCLEAR RESEARCH. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Annu. Rev. Nucl. Sci., 16: 619-42(1966).

A review of the use of on-line computers in high-energy and low-energy physics experiments is presented. (D.C.W.)

17244 POSSIBLE FOCUSING OF PARTICLES IN CYCLIC ACCELERATORS BY MEANS OF CROSSED MAGNETIC AND ELECTRIC FIELDS. Sokolov, A. A.; Loskutov, Yu. M.; Zhukovskii, V. Ch.; Korovin, Yu. A. (Moscow State Univ.). Yadern. Fiz., 5: 309-11(Feb. 1967). (In Russian).

It is shown that particles can be focused not only by means of an inhomogeneous magnetic field, but also by means of a homogeneous magnetic and electric field. The motion of charged particles in the suggested crossed fields is considered, and it is shown that radiation effects cause the damping of axial and enhancement of radial oscillations. (auth)

17245 RADIATION SHIELDING AT THE NRL LINAC FACILITY. Zimmer, Glenn W.; Murray, Kenneth M. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 4: 423-8(Nov. 1966).

High-intensity radiation conditions were established and radiation surveys were conducted under several conditions of operation to verify the shielding calculations which had been made previously, and to determine the effectiveness of the shielding. Problems associated with monitoring x-rays and neutrons from pulsed radiation sources are discussed, along with our methods of calibration and surveying. The results of our studies showed that the effectiveness of the shielding for x-rays could be calculated, but such calculations for neutrons predicted the shielding to be more effective than actually observed. Suggestions for additional work are made, which should help to improve the correlation between the calculated and the measured neutron fluxes. (auth)

17246 HIGH CURRENT LINEAR INDUCTION ACCELERATOR. Pedenko, N. S.; Bolotin, L. I.; Fainberg, Ya. B.; Kharchenko, I. F.; Shepelev, N. P. pp 229-34 of Vzaimodeistvie Puchkov Zaryazhennykh Chastits s Plazmoi. Sinel'nikov, K. D.; Akhiezer, A. I.; Fainberg, Ya. B.; Morgulis, N. D.; Simenko, A. G. (eds.). Kiev, Naukova Dumka, 1965. (In Russian).

A method of generating powerful electron beams and the use of these beams to generate large amplitude electrostatic waves and to heat a plasma are described. The linear betatron constructed for this study consists of an electron source and an accelerating

section formed by a power transformer with unity transformation coefficient. The outline of the design is given in a block diagram and its operation is discussed. An electric field of 6 kV/cm was achieved in the accelerating section. The total potential of 200 kV resulted in electron beam currents of 1000 A. The analysis of the design has shown that the most suitable source of energy is a series of capacitors with spark-gap switching. This scheme eliminates synchronization problems and provides a desirable current pulse. The design reported can basically serve as a guide in the construction of a high-current accelerator operating in the megavolt range. (ATD)

17247 CONTRIBUTION TO THE TARGET PREPARATION FOR LOW ENERGY NUCLEAR EXPERIMENTS. Yamaya, T.; Tohei, T.; Morita, S. (Tohoku Univ., Sendai). Nucl. Instrum. Methods, 49: 173-5(Mar. 1967).

In peeling off the thin target material from glass plate, which was prepared by vacuum-evaporation, glucose was used instead of Teepole. The advantages of this method are described. (auth)

17248 SIMPLE ION BEAM SCANNER. Jagger, J. W.; Page, J. G.; Riley, P. J. (Univ. of Texas, Austin). Nucl. Instrum. Methods, 49: 121-4(Mar. 1967). (ORO-2972-1).

A simple ion beam scanner for continuous monitoring of the properties of an ion beam is described. (auth)

17249 BUILD-UP OF RADIAL OSCILLATIONS INDUCED BY FIRST HARMONIC FIELD ERRORS IN A CYCLOTRON. Lawson, J. D. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 49: 114-16(Mar. 1967).

A formula is derived for the amplitude of radial oscillations in a cyclotron induced by first harmonic errors in the magnetic field, allowing for the variation of free oscillation frequency and harmonic amplitude with radius. Although this is in general tedious to evaluate, the effect of various machine parameters can be seen, and order of magnitude calculations can be made. (auth)

17250 MULTIPLE ACCELERATION SYSTEM FOR AN ELECTRODYNAMIC SEPARATOR OF HIGH-ENERGY PARTICLES. Vagin, V. A.; Volodin, V. D.; Plyashkevich, N. N.; Saenko, A. P.; Semenyushkin, I. N.; Stepanyuk, V. L. Prib. Tekh. Eksp., No. 6, 22-5(Nov.-Dec. 1966). (In Russian).

A system for multiple acceleration of high-energy particles is described. The system recaptures protons in multiple frequency (q = 100) acceleration conditions previously accelerated to maximal energy and continues their acceleration for 15-20 μsec. The system consists of a coaxial resonator, hf units, a pulse modulator, and a synchronizer. The frequency of the multiple acceleration is 149.520 Mc and the pulse duration is 15-20 μsec. A 70% coefficient of proton recapture at beam energy E = 10 GeV, energetic spread $\Delta E = \pm 1.7$ MeV, and amplitude of the accelerating voltage in the resonator $V_r = 70$ kV was obtained during testing of the system on a proton synchrotron. (ATD)

17251 STUDIES OF BETATRON OSCILLATION RESONANCES IN ELECTRON ACCELERATORS AND STORAGE SYSTEMS. Kulikov, O. F.; Moroz, E. M.; Petukhov, V. A.; Shorin, K. N.; Yarov, A. S. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 6, 20-1(Nov.-Dec. 1966). (In Russian).

Dynamics of electron beam transverse motion, recorded by rapid optic radiation filming; intensity losses, recorded by corresponding transducer signals; and excitation regions were studied under conditions of forced excitation of various betatron oscillation resonances. Descriptions of the equipment used and experimental data obtained with a 680-MeV synchrotron and pictures of electron beam cross section at various resonances are included. (tr-auth)

17252 DEVICE FOR MEASURING COHERENT RADIAL-PHASE OSCILLATION PARAMETERS IN A STORAGE RING WITH COLLIDING BEAMS. Pirushkin, E. A.; Starodubtseva, T. P. Prib. Tekh. Eksp., No. 6, 26-31(Nov.-Dec. 1966). (In Russian).

Radial-phase cluster oscillations in a storage ring were analyzed using electrostatic electrode signal harmonic components. The measuring device was used with a storage system with colliding electron-positron beam, and 25 MHz rotation frequency. The device is capable of measuring radial-phase oscillation frequencies of 20 to 200 kHz and frequency deviations of 0.5 kHz and over, starting at 1 mA current and frequencies of amplitude modulation of the first and sixth harmonics on the electrode. (tr-auth)

17253 HIGH-FREQUENCY POWER STAGE EXCITATION CIRCUIT FOR FEEDING CYCLIC AND LINEAR ACCELERATOR RESONATORS. Grits, Yu. A.; Panasyuk, V. S.; Ostreyko, G. N.; Yudin, L. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 6, 39-40(Nov.-Dec. 1966). (In Russian).

In high-power common-grid pulse amplifiers for cyclic or linear accelerators, low efficiency and pulse distortion result from a mismatch between the driver and the power tubes where the second harmonic is undesirable. An excitation circuit is presented in which the fundamental and the second harmonics follow different paths at the power tube cathode input circuit. The interstage circuit between the driver and the power tube consists of a tuned split LC circuit (tuned to the fundamental frequency), two parallel cable sections assuring a high travelling wave ratio for the fundamental and a high impedance for the second harmonic (cable length is such that it acts as a quarter-wave cable for the second harmonic). The second harmonic is further trapped by LC circuits between the power tube cathode and ground. The described circuit was tested using a GK-5A power tube operating at 6.3 Mc in pulsed mode. The output pulse had a power of 3 Mw. Its duration and repetition frequency were 1 msec and 12 cps, respectively. It is claimed that the efficiency of this circuit is 60% greater than that of the simple common grid circuit. (ATD)

17254 USE OF THE CYCLOTRON MAGNETIC FIELD FOR CREATING ELECTRIC CURRENTS IN MEASURING SYSTEMS. Spinko, N. V.; Fedorov, N. D. (Inst. of Nuclear Physics, Alma-Ata, USSR). Prib. Tekh. Eksp., No. 6, 41-3(Nov.-Dec. 1966). (In Russian).

A system is described for controlling a probe used in determining beam current and positron in a cyclotron. The system operates by using the magnetic field in the cyclotron gaps to produce currents in a rheostat which controls the rectilinear motion of the probe. (R.V.J.)

17255 THEORY OF CYCLIC ACCELERATORS. Kolomenskii, A. A.; Lebedev, A. N. New York, John Wiley and Sons, Inc., 1966. 416p. $15.50.

Translated from Teoria Cikliceskich Uskoritelej by M. Barbier.

A systematic development of the general theory of modern accelerators, as well as a description of the features of devices of various types are presented. Topics discussed in detail are betatron oscillations of particles in ideal periodic magnetic fields, betatron oscillations of particles in nonideal magnetic fields, synchrotron oscillations, radiation effects in cyclic electron accelerators, particle losses caused by random perturbations of the motion, and peculiarities of accelerators of different types. (B.G.D.)

17256 TRANSFORMER-TYPE PARTICLE ACCELERATOR. Utsunomiya, Shinhachi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7392. Apr. 22, 1966. Filed Jan. 18, 1965.

In the transformer type particle accelerator proposed, the occurrence of an abnormal voltage at the accelerating power source is prevented. The transformer-type particle accelerator has a pulsed-particle generator with a device for adjusting the pulsed-particle rise-time; and an accelerating power source with a device for adjusting the resonance frequency, by means of which the pulsed particles are accelerated by applying high voltages to the accelerating electrodes through a plurality of high-voltage transformers connected in a cascade. By adjusting both the rise-time and the resonance frequency, the occurrence of an abnormal voltage at the accelerating power source can be prevented during the particle acceleration. (NSA of Japan)

17257 STRONG FOCUSING OF HIGH ENERGY PARTICLES IN A SYNCHROTRON STORAGE RING. Beth, R. A. (to U. S. Atomic Energy Commission). U. S. Patent 3,303,426. Feb. 7, 1967.

A magnet having edges oblique to the path of a beam of charged particles whereby the particles in the beam are focused by alternating gradient strong focusing is described. In the several embodiments contemplated, the edges are curved or straight and the pole faces are parallel or tapered. (AEC)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 17340, 17453, and 17530.

17258 (AD–645929) A SOURCE-ENERGY INTEGRATION PROGRAM DESIGNED TO OPERATE ON THE NGM CODE OUTPUT. Lacetera, Joseph (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Jan. 1967. 88p. (NDL-TM–35).

The Los Alamos Scientific Laboratory is preparing a neutron-gamma Monte Carlo (NGM) transport code that will provide differential data for use in mapping the initial radiation environment created by a nuclear detonation. A digital-computer program is described which was written for the GE 225 computer in the General Assembly Program (GAP) language. The program integrates the LASL NGM radiation transport code differential flux output with the source-energy variable weighted by a user-supplied function. The resultant output is the flux at the detectors due to the user-supplied source-energy spectrum. The method of performing the weighted source-energy integration operation and the use of checksums to minimize error are given through the use of a flow diagram with complementary textual description, and the GAP source-deck listing. A method of running the program and response to the error signals is also described. (S.F.L.)

17259 (AD–646458) TIME DEPENDENT NEUTRON TRANSPORT FROM A POINT ISOTROPIC SOURCE AT AN ALTITUDE OF (24,384KM) 80,000 FT. George, James P.; Lavagnino, Albert (Braddock, Dunn, and McDonald, Inc., El Paso, Tex.). June 28, 1966. 279p. (DASA–1820-1). CFSTI $3.00 cy, $0.65 mn.

The results of a run of the AUGEAS Monte Carlo neutron transport code are presented. The neutron sources used are isotropic and monoenergetic, with source energies between 0.01 and 14 MeV. The source altitude is 80 kilofeet in a reference atmosphere. A detailed rationale for locating the neutron detector is given. The neutron flux, resolved into 20 time intervals, and the neutron fluence, resolved into 16 energy intervals, are reproduced from the code output. Comprehensive total fluence curves are presented. Detailed flux vs time and fluence vs energy histograms are presented for the representative source energies 14 and 1.4 MeV. (auth)

17260 (BMwF-FBK–66-40) STREUUNG LANGSAMER NEUTRONEN IM ZIRKONHYDRID. (Scattering of Low Energy Neutrons in Zirconium Hydride). Roehrborn, B. (Technische Hochschule, Karlsruhe (West Germany). Institut fuer Theoretische Kernphysik). Dec. 1966. 53p. (In German). Dep. mn.

For Bundesministerium fuer Wissenschaftliche, Bad Godesberg, West Germany.

Calculations are made of neutron scattering in zirconium hydride taking into account the chemical binding of the hydrogen atom in the crystal system. It is shown how this can be done based on theory developed by Zemach and Glauber. The spectrum of the crystal frequency distribution is approximated as proposed by Nelkin and Rosenbluth. Calculations are compared with neutron scattering experiments by Parfenov (Dubna) and the experimental results by Pan and Webb (Troy, N. Y.). Some parameter studies were done in order to prove the applicability of Nelkin's model for the calculation of neutron flux distribution in zirconium hydride. With some of these parameters, which are consistent with crystal physics, the qualification of this model for neutron spectra in zirconium hydride is demonstrated. Calculations were compared with experimental neutron spectra given by Beyster et al. (auth)

17261 (IN–1045) MULTIPLE SCATTERING OF THERMAL NEUTRONS. Plummer, J. P. (Idaho Nuclear Corp., Idaho Falls). Feb. 1967. Contract AT(10-1)-1230. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The quantum mechanical treatment of multiple scattering developed by Watson et al. is examined and is applied to thermal neutron scattering in the static approximation. It is shown that recent efforts along similar lines appearing in the literature have been oversimplified approaches to a very complex problem. (auth)

17262 (JAERI–1113) INELASTIC SCATTERING OF NEUTRONS. Conference held November 15–18, 1965, Tokyo, Japan. (Japan Atomic Energy Research Inst., Tokyo). Sept. 1966. 135p. (In Japanese and English). (CONF-651152–). Dep. mn.

Separate abstracts were prepared of 11 of the 22 papers included. The remaining papers deal with the theory of liquids and liquid metals and of magnetic scattering. (D.C.W.)

For abstracts of individual papers see: 16138, 16961–16964, and 17263–17268.

17263 (JAERI–1113, pp 13–26) REACTOR PHYSICS AND THERMAL NEUTRON SCATTERING. Takahashi, H. (In Japanese and English).

A review is presented on inelastic scattering of thermal neutrons by moderating materials. Several models which are discussed in connection with scattering by water, heavy water, graphite, and beryllium are those due to Butler, Engelstaff and Schofield, Kitano and Parks, Nelkin, and Yoshimori. Analyses of experimental data by these models are discussed. (S.F.L.)

17264 (JAERI–1113, pp 27–31) NEUTRON SCATTERING BY POLYCRYSTALS. Iijima, S. (In Japanese and English).

A discussion is given of problems encountered in the analysis of slow neutron scattering by polycrystalline materials. The discrepancy between calculations and measurements of the total cross section for graphite at very low energy is discussed, including the possibility that the measured cross section may include defect scattering due to the presence of amorphous carbon atoms in artificial graphite. One-phonon coherent scattering from polycrystals is discussed. The dispersion relations for a cubic Bravais crystal are simplified by assuming that two of the branches are purely transverse and the other is purely longitudinal; that two transverse frequencies are degenerate; and that the frequency contours are spherical. With these assumptions, the one-phonon coherent scattering can be expressed in an analytical closed form. Using the frequency distribution and the frequency contour map calculated by Walker, the formula was applied to aluminum. The results were in fair agreement with the scattering law data measured by Brugger et al. The criteria of the validity of the above assumptions, and the feasibility of an extrapolation procedure are discussed. (S.F.L.)

17265 (JAERI–1113, pp 32–5) ELEMENTARY EXCITATIONS IN LIQUID HELIUM. Abe, R. (In Japanese and English).

Some recent developments in the inelastic scattering of neutrons in liquid helium are presented, and its relation to the properties of elementary excitations is discussed. (auth)

17266 (JAERI–1113, pp 91–8) SPIN WAVES AND NEUTRON INELASTIC SCATTERING. Hirakawa, K. (In Japanese and English).

A review of principles and experimental methods of neutron inelastic scattering by spin waves and some recent observations of spin waves in magnetic crystals is given. It consists of spin-wave renormalization, effects of the higher-order terms in spin-wave energies in metals, the exchange stiffness in 3d transition metal alloys, and the small-angle scattering method which was developed by Lowde. (auth)

17267 (JAERI–1113, pp 122–6) EXPERIMENTAL RESULTS OF THE MAGNETIC CRITICAL SCATTERING OF NEUTRONS. Hamaguchi, Y. (In Japanese and English).

The experimental results of critical neutron scattering (the abnormal scattering of neutrons near the critical temperature) by several ferro- and antiferromagnetic substances are discussed from the viewpoint of experimental accuracy. (auth)

17268 (JAERI–1113, pp 128–30) THE FLUCTUATION–DISSIPATION THEOREM AND NEUTRON SCATTERING. Kubo, R. (In Japanese and English).

Some aspects of the linear response theory are discussed in connection with the inelastic scattering of neutrons. Also, it is pointed out that scattering experiments in nonequilibrium states should become important in the future. (auth)

17269 (KAPL-M–6563) CROSS SECTION SENSITIVITY CALCULATIONS FOR SMALL HYDROGEN MODERATED SYSTEMS. Weinstein, S.; Feiner, F.; Cooper, K. V.; Armstrong, S. I. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nov. 29, 1966. Contract W-31-109-eng-52. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Effective multiplication constants were calculated for three small hydrogen-moderated solid homogeneous assemblies in the P-3 multigroup approximation using a number of compilations of epithermal microscopic cross section data. These compilations included the evaluated cross section libraries for O, C, Zr, and ^{238}U that were used at the Knolls Atomic Power Laboratory, and for the same elements, a library set modified to accentuate inelastic scattering and anisotropic elastic scattering effects. (auth)

17270 (RPI–328–71) LINEAR ACCELERATOR PROJECT. Annual Technical Report, July 1966–September 1966. Gaerttner, Erwin R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 97p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The sensitivity of a neutron-capture detector to prompt neutron scattering was investigated. The capture cross sections of Al, Fe, ^{56}Fe, ^{57}Fe, ^{58}Fe, Ni, ^{58}Ni, ^{60}Ni, ^{61}Ni, ^{64}Ni, and Na were measured at energies from about 10 keV to a few hundred keV. The total neutron cross sections of C, Ta, W, ^{182}W, ^{184}W, and ^{186}W were measured from 0.4 to 20 MeV. Gamma spectra from neutron capture by ^{198}Hg, ^{199}Hg, ^{182}W, and ^{183}W were analyzed; transition strengths were obtained. The average neutron number/fission of ^{235}U was measured over the neutron energy range from 2.5 to 9.0 eV, and the scattering cross sections of ^{239}Pu, ^{233}U, and ^{235}U were measured for neutron energies between 1 and 100 eV. Preliminary transmission measurements of the neutron total cross sections of ^{147}Pm and ^{148}Pm were made over the energy range from 1 eV to 2 keV; a graphical area analysis was performed to obtain parameters for the 15.6 eV ^{147}Pm resonance. Time-dependent neutron spectra were measured in light water, and a computer program was written to analyze the data. A facility for studying low-energy neutron inelastic scattering was investigated, and measurements were made for scattering by polyethylene, NbH, ZrH, and UO_2. Codes were also written to automate data reduction. Transient radiation effects in silicon were investigated using a pulsed 50-MeV electron beam. (D.C.W.)

17271 AN ESTIMATION OF CRYSTAL BINDING EFFECT OF UO_2 ON THE EFFECTIVE RESONANCE INTEGRAL. Kadotani, Hiroyuki (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 4: 40-2(Jan. 1967).

A calculation of the effect of crystal binding on the effective resonance integrals for UO_2 is summarized; the results are presented. (D.C.W.)

17272 CONCERNING THE NUMBER OF RESONANCES MISSED DUE TO IMPERFECT EXPERIMENTAL RESOLUTION. Wilkins, Coleridge A. (Wollongong Univ. Coll., New South Wales). J. Nucl. Sci. Technol. (Tokyo), 4: 37-9(Jan. 1967).

Fuketa and Harvey have estimated the number of missed resonances in an energy interval by assuming that resonances are uniformly and regularly spread. This assumption is dropped, and both prior and posterior averages for the number of missed resonances are given. A number of other results are given concerning the statistical model for resonance spacings. (auth)

17273 MONOENERGIC NEUTRON LEAKAGE FROM ONE-DIMENSIONAL SMALL SYSTEMS. Fukai, Yuzo (Nippon Atomic Industry Group Co., Tokyo); Makino, Kakuji. J. Nucl. Sci. Technol. (Tokyo), 4: 21-6(Jan. 1967).

Leakage rates of monoenergic neutrons from small slab and cylindrical systems with isotropic scattering and neutron source are accurately calculated by the collision probability method. The diffusion theory is then improved by adjusting the extrapolated distance used in the theory to be in agreement with the exact leakage rate. The characteristics of the extrapolated distance, peaking factors, and the effect of different configurations of source distribution are discussed. Finally, the equivalence between slab and cylindrical systems is derived. (auth)

17274 MULTIDIMENSIONAL SPHERICAL HARMONICS METHOD FOR ENERGY DEPENDENT PROBLEMS. Dede, K. M. (Inst. for Experimental Physics, Hungarian Academy of Sciences, Debrecen). Nukleonik, 8: 383-8(Sept. 1966).

The explicit multidimensional spherical harmonics formalism is extended to energy-dependent problems. Angular- and space-energy dependence are separated. The former can be treated as in the one-velocity case, the latter as in the one-dimensional case. As an illustration multidimensional P_NL_Q approximation is developed. (auth)

17275 VACUUM BOUNDARY CONDITIONS FOR MULTIDIMENSIONAL SPHERICAL HARMONICS METHOD. Dede, K. M.; Boedy, Z. T. (Inst. for Experimental Physics, Hungarian Academy of Sciences, Debrecen). Nukleonik, 8: 388-96(Sept. 1966).

A "selecting rule" is derived for choosing appropriate sets of Marshak-type vacuum boundary conditions in multidimensional P_N approximation. The boundary conditions proposed by Rumyantsev, Emendörfer and Vladimirov satisfy this rule, those of Davison and partly those of Noble and Mingle do not. A multidimensional generalization of Mark's boundary conditions is given. The rate of convergency obtained by different sets of boundary conditions is tested on a multidimensional version of Milne's problem, in this example the selecting rule derived seems to work well. A small dependence of the extrapolation length on lateral flux variation is shown. Tables useful for practical applications are included. (auth)

17276 ENERGY DISTRIBUTIONS OF INELASTICALLY AND ELASTICALLY SLOWED DOWN FAST NEUTRONS. Syros, Constantin (EURATOM-CCR, Ispra, Italy). Nukleonik, 8: 396-405 (Sept. 1966).

An analytical method for the solution of the inelastic slowing down problem is presented. As elastic and inelastic scattering can not be separated, one necessarily has to consider both modes of slowing down. The solution of the combined problem is obtained by putting elastic and inelastic scattering on the same footing. This was done by considering elastic scattering as being inelastic with Q-value identically equal to zero. This method which is based on Laplace-transform techniques provides as a special case the classical Placzek distribution. By using a reasonable approximation the solution with energy-dependent cross sections is obtained. The solutions given here can be used to construct the solution of the Boltzmann's equation in energy- and space-dependent problems. (auth)

17277 INTRODUCTION OF GROSS LEAKAGE INTO FINE STRUCTURE CALCULATIONS. Pomraning, G. C. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nukleonik, 8: 372-8(Sept. 1966).

A method is presented which introduces gross leakage into fine structure cell calculations. The basis of the method is a simple neutron conservation argument which couples the escape probability formulation of the fine structure problem with the asymptotic (B–N) equations describing gross leakage. The resulting coupled set of equations is shown to reduce to exact equations in three limiting cases (no gross leakage, no fine structure, small cell). The slowing down problem is explicitly considered as an application of these equations. In particular, the off-resonance solution is investigated in connection with the narrow resonance (applied to the moderator) approximation. Equations are given which quantitatively indicate the effects of gross leakage on the hardening of the cell spectrum. The application of this work to the general problem of obtaining cell homogenized multigroup constants is discussed. (auth)

17278 PRODUCTION AND USE OF THERMAL REACTOR NEUTRON BEAMS. Maier-Leibnitz, H. (Technische Hochschule, Munich); Springer, T. Annu. Rev. Nucl. Sci., 16: 207-62(1966).

A review of the use of thermal reactor beams in physics research, excluding nuclear physics, is presented. Experimental methods using reactor neutron beams are discussed, together with applications of reactor neutron beams in research. 144 references. (D.C.W.)

17279 ANISOTROPY OF THE SCATTERING IN SPACE–TIME NEUTRON TRANSPORT THEORY. Boffi, V. C.; Trombetti, T. (CNEN, Bologna). Nuovo Cimento (10), 47B: 210-34(Feb. 11, 1967).

The L-transformed space-angle-time solution of the Boltzmann equation in the case of infinite plane symmetry, anisotropic scattering, constant cross sections, and a unit-strength infinite plane isotropic pulsed source of monoenergetic neutrons is worked out in terms of the eigenfunctions, which correspond to the eigenvalues associated with the non-Hermitian operator of the given balance transport equation. These eigenvalues are seen to separate into a discrete and continuous spectrum. It is then shown that, among the eigenvalues belonging to the discrete spectrum, at least one can in general be extracted and expressed as a power series of the complex parameter associated with the Laplace integral. This turns out to be very useful when the L-transform of the sought solution is to be inverted. It is thus possible to recognize that the transport solution obtained is asymptotic to the result of the simple diffusion theory. (auth)

17280 CADMIUM RATIOS AND RESONANCE SELF-SHIELDING FOR THICK GOLD AND INDIUM FOILS ACTIVATED IN THE REACTOR. Khristov, V. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 33-8(1966). (In Russian).

Numerical computations were made of the coefficients for resonance self-shielding for round gold and indium foils with thicknesses varying from 0 to 100 mg/cm^2, activated with reactor neutrons. Good agreement was achieved between the curves calculated and the results from the cadmium ratios measured in the irradiation of gold and indium foils both in an isotropic flux and with a collimated beam of neutrons of the IRT Reactor in Sofia. The data on the true cadmium ratios coincide well with those calculated by Westcott's semi-empirical method. Taking into account that gold and indium are some of the most widely used neutron activation detectors, the calculated curves may prove useful in some activation and spectrometric studies with neutrons carried out in reactors. (auth)

17281 GENERALIZATION OF THE VARIATIONAL METHOD OF KAHAN, RIDEAU, AND ROUSSOPOULOS. II. A VARIATIONAL PRINCIPLE FOR LINEAR OPERATORS AND ITS APPLICATION TO NEUTRON-TRANSPORT THEORY. Kostin, Morton D. (Princeton Univ., N. J.); Brooks, Harvey. J. Math. Phys. (N. Y.), 8: 53-6(Jan. 1967).

Additional applications of a generalized form of the variational method of Kahan, Rideau, and Roussopoulos are presented. Equa-

tions used in neutron transport theory, such as the spherical harmonics operator form of the Boltzmann equation, are derived from the generalized variational functional; and an interpretation of these operator equations in terms of flux- and source-generating operators is suggested. A relation between this variational method and the variational method of Lippmann and Schwinger is established, and it is shown that the least-square variational functional of Becker for linear equations can be derived from a generalized variational functional. (auth)

17282 TIME SPENT BY NEUTRONS INSIDE A NARROW RESONANCE. Wilkins, C. A. (Wollongong Univ. Coll., Australia). J. Proc. Roy. Soc. N. S. W., 100: 25-7(1966).

It is pointed out that in previous investigations of the time scale of the slowing-down process of neutrons in infinite homogeneous reactors it has not been noted that when the slowing-down density is known exactly for arbitrary cross sections, the moment-generating function of the slowing-down time may be determined explicitly. In particular, an explicit expression may be derived for the moment-generating function of the time spent by a neutron inside a Spinney-type resonance, i.e., a resonance with a width less than or equal to min $E_u(1-\alpha_i)$ where E_u is the upper cut-off energy of the resonance, α_i, is defined by $\alpha_i = [(1-A_i)/(1+A_i)]^2$, and A_i is the mass of the i-th species in the mixture. The expression is derivable from the expression for the slowing-down density. The same method may be applied to wider resonances. (BBB)

17283 TENSOR DIFFUSION OF NEUTRONS IN HETEROGENEOUS PERIODIC MEDIA FOR CASE OF ARBITRARY SCATTERING LAW. Novikov, V. M. At. Energ. (USSR), 21: 272-6 (Oct. 1966). (In Russian).

A general quadratic formula was obtained for the diffusion coefficient tensor in heterogeneous periodic media with an arbitrary scattering law. In contrast to the homogeneous system, in which the scattering anisotropy is expressed in the diffusion length only by a mean angle of scattering cosine, in the heterogeneous media the diffusion length is determined by angular moments higher than the indicatrix of scattering. Using an example of a medium with an empty channel, it is shown that the consideration of the scattering anisotropy would result in α_i^2 expressions which differ from the known Behrens formulas. An analysis was made of the theoretical and experimental data. (R.V.J.)

17284 PENETRATION OF NEUTRONS IN AIR. Yampolskii, P. A.; Kokovikhin, V. F.; Golubkov, A. I.; Kondurushkin, N. A.; Bolyatko, A. V. At. Energ. (USSR), 21: 262-6(Oct. 1966). (In Russian).

The distribution of neutrons in infinite homogeneous normal density media at various distances from the monoenergetic point isotropic source was studied using the Monte Carlo method. The initial energy of the neutrons was 0.001, 0.025, 0.2, 0.8, 2, 5, 10, and 14 MeV. The space-energy and time distribution of neutrons was investigated at 10 to 1300 m from the source. The results were compared with published experimental data. (tr-auth)

17285 METHOD OF PHOTOGRAPHING A BEAM OF THERMAL NEUTRONS. Gadjokov, V.; Enchev, D.; Misheva, M.; Toumbev, G. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 65-6 (1966). (In Russian).

A method was developed for the photographing of a beam of thermal neutrons in the presence of a strong gamma background, making use of a "sandwich" of photographic paper with a thin (0.25 mm) layer of a mixture of ZnS(Ag) and boron at a ratio of 1:1.5. (auth)

17286 AN ESTIMATE OF THE ENERGY OF Sb–Be PHOTONEUTRONS FROM A MEASUREMENT OF THE ^{124}Sb GAMMA RAY ENERGY. Ryves, T. B.; Beale, D. W. (National Physical Lab., Teddington, Eng.). Int. J. Appl. Radiat. Isotop., 18: 204-5 (Mar. 1967).

A measurement is described of the energy of the principal high-energy gamma ray of ^{124}Sb at about 1.69 MeV, made for the purpose of calculating the energy of Sb–Be photoneutrons, to an accuracy of ± 1 keV. It is pointed out that in the interpretation of neutron capture cross sections measured at the energy of Sb–Be photoneutrons, the neutron energy should be known to better than 1 keV to take account of the closely spaced resonances which occur. The experimental set-up included a lithium-drifted germanium crystal coupled to a system of amplifiers and a 400-channel analyzer. The weighted average ^{124}Sb gamma energy was measured to be 1690.7 ± 0.4 keV. Using a Q-value of 1665 ± 0.6 keV for the ^{9}Be (γ,n) reaction, the photoneutron energy was calculated to be 22.8 ± 1.0 keV. (UK)

17287 THRESHOLD DETECTOR STUDY OF NEUTRON SPECTRA IN WATER FROM A 14.7 MeV SOURCE. Deleray, Arthur Loyd. Princeton, N. J., Princeton Univ., 1966. 234p. Thesis.

An experimental investigation of the energy and spatial distribution of neutrons from a D(T,n)^{4}He source in water was conducted with the threshold detector technique. Fourteen threshold detector reactions were experimentally studied at nine different positions between 5.9 and 39.9 cm from the source in the forward direction. Several detector reactions are rendered useless by unacceptably large corrections or insufficient cross-section data. The shapes of the detector cross-section curves and the neutron-flux energy spectra, which are predominantly virgin (uncollided), are such that the physical reaction thresholds are ineffective for providing flux energy spectra information. A Monte Carlo calculation, which uses a collision density approach, provides a theoretical energy and spatial neutron flux distribution. Activation integrals are used to compare the experimental results with the Monte Carlo calculated results and also with the results of a moments method solution of the Boltzmann equation. Experiment appears to be in reasonable agreement with theory; however, the comparison is confounded with the uncertainties in the cross-section data. (Diss. Abstr.)

17288 TABLE OF RESONANCE INTEGRALS. Vidal, R.; Rouillier, F. (CEN, Fontenay-aux-Roses, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/73, 14p. (In French). (CONF-661014–39). DTIE.

From IAEA Conference on Nuclear Data, Paris.

The measured resonance integrals for a number of materials are regrouped after correcting them with a view to reducing them to a common definition, and to compare them with the value calculated from resonance parameters, when these parameters are known with a sufficient degree of accuracy. These comparisons are made for use with the infinite dilution method. The resonance integral above the 1/V part, which corresponds to infinite dilution, is defined by the relation: $I = \int_{E_c}^{\infty}[\sigma(E) - \sigma_0\sqrt{E/E_0}]\,dE/E$. From this the total integral I_R is derived by selecting the lower limit of integration E_c equal to 0.55 eV. Only those materials are studied for which the lowest resonance wing is extinguished at this energy. The resonance integrals calculated from the parameters are determined for infinite dilution by means of the ZUT computation program and the complementary TUZ program for the contribution of unresolved resonances. Corrections were made in the measured resonance integrals in order to standardize and thereby facilitate comparisons. These consisted, in particular, in the following: calculation of the 1/V part in order to obtain I from I_R; modification of quenching in order to reduce them to energy E_c = 0.55 eV; standardization relative to the resonance integral for gold, taken as equal to I = 1540 b and to the cross-section at 2200 m/s of natural boron, taken as equal to 761 b or 771 b, depending on the isotopic concentrations; extrapolation to infinite dilution; and adoption, if necessary, of the final thermal cross sections when they enter into the calculation of I. (auth)

17289 VERTICAL NEUTRON GENERATOR. Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7391. Apr. 22, 1966. Filed Mar. 16, 1965.

In the vertical neutron generator proposed, the shielding of the neutron-irradiation compartment (or room) is simplified and useful deuterons can be selectively drawn out for the neutron production. In the neutron generator, deuterons are produced from an ion source, then are accelerated in the evacuated accelerating tube by applying a dc voltage of 100 to 200 kV, and are allowed to impinge upon a tritium target, to produce 14.6 MeV neutrons by the T(d,n)^{4}He reaction. The vertical neutron generator consists of the following: the box-shaped support (for the accelerating tube etc.) installed on the floor, with a hole penetrating vertically at the middle (but it opens only at the top); the target room at the lower end of this hole; the series of an accelerating tube, ion source, etc., which is connected to the opening of the vertical hole with the series diverging at a certain angle from the axis of the hole; and the device, installed at the diverging point, for deflecting the accelerated ions and introducing only the useful ions (i.e., deuterons) into the target room. The box shaped support in which the target room is located, is filled with shielding materials for shielding against the neutrons. (NSA of Japan)

17290 PULSED BEAM GENERATOR. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1966-4159. Mar. 12, 1966. Filed Aug. 28, 1963.

A pulsed beam is often used in the studies on a nuclear reactor and nuclear physics-studies. In experiments on the lifetime of neutrons, a very narrow pulsed beam is frequently required to measure accurately the velocity of the neutrons. A pulsed beam generator is proposed which can meet such a requirement. It consists in general of an ion (or electron) source, a focusing device for the emitted ion, a deflecting device for the focused ion, and an orifice for intermittently injecting the ion (from the deflector) into an accelerating tube. An electrode is installed between the de-

flecting device and the orifice to which a voltage, delayed in phase by the TC/2 from the deflecting voltage, is applied. (auth)

17291 A STUDY OF EXTRAPOLATION LENGTHS IN THIN SLABS IN HIGH ORDER P_N APPROXIMATIONS. Emon, Donald Edward. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 150p.

Thesis.

The pulsed-neutron experiment has gained an increasing amount of attention as a technique for measuring nuclear parameters. Because the sample is irradiated for only a very short time with an intense burst of neutrons, a time-dependent neutron flux results. The customary approach used in evaluating the smallest time decay constant for the system is to use a power series expansion in terms of the material buckling. The coefficients in this expansion depend on the composition, temperature and density of the material. By taking the extrapolation length to be a function of the geometrical buckling, the material and geometrical buckling are shown to be equal. The remaining problem of finding the buckling dependence of the extrapolation length is the primary subject dealt with in this study. A theoretical expression for the extrapolation length associated with slabs of varying thicknesses for any order multigroup P_N approximation is derived. Closed solutions for this expression are obtained in the one-group P_1 and P_3 and the two-group P_1 approximations. For higher-order approximations, the time decay eigenvalue versus buckling relation becomes too complex to evaluate analytically and previously established numerical techniques are used. Numerical results are presented for the P_1 through P_7 approximation for one- and two-energy groups and in the four-group P_7 approximation. Water is the primary medium studied, although variations in the temperature of the Maxwellian spectrum used to average cross sections, the energy dependence of the transport cross section, the mass of the scattering kernel, and the order of the P_N approximation are also investigated. (Diss. Abstr.)

17292 EFFECTS OF COHERENT SCATTERING ON THE THERMALIZATION OF NEUTRONS IN BERYLLIUM. Fullwood, Ralph Roy. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 191p.

Thesis.

Time-dependent neutron spectrum measurements in beryllium metal were performed in the neutron energy range 0.005 to 0.1 eV for four bucklings in the range 0.12 to 0.013 cm^{-2} and for time ranging from one to six thermal mean lifetimes in some cases. These measurements were performed using the pulsed-Linac-phased-neutron-chopper technique. Neutron energies were measured by time-of-flight techniques. Good agreement with available theoretical spectrum calculations was found. The theoretically predicted neutron trapping in the coherent scattering peaks was observed and the correct magnitude was confirmed. A time-asymptotic neutron energy spectrum was found in the media for bucklings of 0.013 and 0.075 cm^{-2} but was not found for the bucklings 0.075 and 0.12 cm^{-2}, for time as long as six thermal mean lifetimes in one case. This is in agreement with the recently proposed theories associated with the upper bound on the eigenvalue spectrum and Corngold's Buckling-Bound Theorem. The bucklings were chosen so that two of the values would lie in the discrete eigenvalue range and two would lie in the range of continuous eigenvalues. A companion experiment was performed that gives further credence to the theoretical bound on the eigenvalue spectrum. Die-away measurements were performed on all buckling values. The smaller buckling values showed the usual spatial modal contamination, however, the two larger buckling values suggested the nonexistence of discrete eigenvalues and showed a long decaying portion of approximately 300 μsec decay time in reasonable agreement with a theory relating to neutron trapping. For purposes of reactor calculations in which beryllium is used as a reflector or moderator, an asymptotic trial spectrum consisting of an ambient Maxwellian distribution having a neutron trapping peak centered at 0.0085 eV is recommended. The fraction of neutron flux in the trapped peak relative to the thermal group is 0.69% and 1.54% for the bucklings 0.013 and 0.026 cm^{-2}, respectively. No such recommendations are available for the 0.075 and 0.12 cm^{-2} bucklings inasmuch as no stable spectrum was found for these measurements. This trapped group may be represented as a delta function as was done by Daitch and Ebeoglu or as a Gaussian-like group having a full width at half maximum of 0.003 eV. A correctional scheme was devised to correct for the chopper drift distance when the time dependence of the spectrum is not a single exponential. All important computer codes are presented in the appendix as well as a description of their operation. In light of the current theories and this experiment, serious doubts are cast upon previous experiments designed to measure the diffusion parameters of crystalline materials by the die away technique. The theory and analysis technique should be reexamined to include explicitly the coherent scattering effects as well as the eigenvalue and buckling bound. (Diss. Abstr.)

17293 REPRESENTATIONS OF NEUTRON SPECTRA FOR THERMAL AND EPITHERMAL ENERGIES. Hobson, Robert Larrie. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 357p.

Thesis.

In this study the use of orthonormal expansions of eigenfunctions and steady-state neutron spectra is investigated to determine the applicability and worth of such expansions in the calculation of the eigenvalues, eigenfunctions, time-dependent spectra, and steady-state spectra in the practical environment of quantitative results useful to the experimentalist. The particular study model has been to use the mass-1 proton gas energy exchange kernel so that analytical and numerical calculations could be directly compared. Some of the formal expansion methods proposed by other authors are investigated and are found to have serious deficiencies in their ability to match such common reactor parameters as nonmonotonic total cross sections and in the requirement to be useful in numerical applications. The innovation of orthonormal functions based on the Gram-Schmidt orthogonalization technique shows more promise, particularly in the description of steady-state spectra. The use of certain functions of a discontinuous nature has shed light on some recent problems encountered in the use of the Gram-Schmidt method. The attempt to extend the analysis to the epithermal range (>1.0 eV) has brought to light a serious drawback to methods requiring the orthonormal expansion of the eigenfunctions used in attempts to calculate time-dependent spectra. One requires absolute accuracy, not only in the most significant portion of the eigenfunctions determined, but also in the exponential tails of these functions at higher energies, since the adjoints which are required for the determination of these spectra are proportional to the eigenfunctions divided by a Maxwellian. Errors in the eigenfunctions at the upper energy end can completely dominate the calculation of the adjoint although these errors are insignificant in the eigenfunctions themselves. An estimate of the upper energy limit to which these methods can be applied is obtained. Certain basic items concerning the use of the orthonormal expansions in quantitative calculations indicate the applicability of these methods is restricted to low-order approximations for the lowest eigenvalues or asymptotic spectrum in the time dependent problem, while the steady-state problem is amenable to solution in this fashion. One can conclude that for the actual description of time-dependent and steady-state spectra, the discrete ordinates or multigroup methods appear to be the methods most capable of providing accurate results. (Diss. Abstr.)

17294 THE MEASUREMENT OF TIME-DEPENDENT THERMAL NEUTRON SPECTRA IN A PULSED HOMOGENEOUS D_2O MEDIUM. Kryter, Robert Conrad. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 286p.

Thesis.

The thermalizing properties of heavy water were investigated by measuring the differential flux, $\Phi(E,t)$, existing in a 50 cm cube ($B^2 = 0.0102$ cm^{-2}) of 99.76 mole-% D_2O maintained at 43.3°C, following a pulse of fast neutrons from an external source. The experimental technique utilizes a phased slow neutron disc chopper in conjunction with the pulsed RPI linear electron accelerator for isolating the time variable, while energy determination is accomplished by measuring neutron time of flight over a 3.1-m shielded flight path. "Life-history" curves are presented for several typical neutron energies, as well as neutron spectral distributions for times varying between 20 and 200 μsec after the fast neutron pulse. The energy range considered is about $0.6 \geq E \geq 0.006$ eV. The early-time thermalization spectra display marked spectral shifts from the asymptotic diffusion-cooled Maxwellian. The flux-weighted mean energy at t = 40 μsec, for example, is about 0.137 eV. The thermalization process proceeds rapidly and is essentially complete at t = 200 μsec following the fast pulse; the kinetic temperature of the diffusion-cooled Maxwellian distribution at that time differs by only 3°K from its asymptotic value (measured at t = 1000 and 2000 μsec by a modified technique). This compares with experimentally determined asymptotic energy distribution attainment times of 150–600 μsec reported in the recent literature. Detailed calculations of the spectra were made using a digital computer to obtain a numerical solution of the time- and energy-dependent P_1 and diffusion equations. The experimental results are compared with calculations based on both a free gas scattering kernel of mass 3.597 and on a bound, incoherent scattering kernel for D_2O which employs the level parameters of H. C. Honeck but includes oxygen energy exchange. Neither kernel predicts spectra in satisfactory agreement with experiment and neither is clearly superior to the other when one considers all regions of energy/time space. In the very early time region, the Honeck kernel appears to transfer energy too rapidly, while the opposite appears to be true of the Mass-3.597 free gas kernel. At intermediate times, both kernels yield a spectrum which is too "soft" (thermal) compared to the experiment, while this situation re-

verses itself in the full asymptotic limit. Both kernels, however, concur with the experiment in that they predict that the thermalization process should be essentially complete at 200 μsec. The center spectrum measured at essentially "infinite" time following the initiating pulse was found to be characterized extremely well by a Maxwellian distribution with a neutron temperature about 9.8 ± 0.4°K below the physical temperature of the heavy water. This amount of diffusion cooling is in satisfactory agreement with the value predicted by a first-order relation between the fractional temperature shift and the diffusion cooling coefficient due to R. R. Fullwood, but is at variance to the temperature shift value of about 2.5°K obtained by subjecting the "infinite-time" theoretical spectra produced by both free gas and bound scattering kernels to the same fitting procedure used for the experimental data. (Diss. Abstr.)

17295 TRANSMISSION OF NEUTRONS THROUGH MULTIPLYING MEDIA. Michael, Paul. New York, New York Univ., 1959. 105p.

Thesis.

In the direction of amplification individual Convergatron stages consist of a moderating region followed by a fissioning region. States are separated from one another by an absorber of thermal neutrons such as cadmium. Forward flow is possible because unmoderated neutrons can penetrate the absorber region and feedback is inhibited by the moderator region which will tend to thermalize neutrons diffusing through the moderator in the direction opposite to the amplification direction. The body of this research is to determine the transmission of neutrons through individual stages in each direction and to determine the overall characteristics of coupled stages. Transmission through homogeneous regions is calculated by a two direction, two energy group approximation to the transport equation. The equations derived allow for anisotropic scattering to be considered. The equations are of the same order as the usual diffusion equations and are shown to be equivalent but allow for the application of more realistic boundary conditions. Multiple regions are treated by considering transmission and reflection from homogeneous subregions. The output of the jth stage, ϕ_j, of a Convergatron is shown to be related to the output of the adjacent stages by an equation of the form: $\phi_j = G\phi_{j-1} + \Gamma\phi_{j+1}$. Figures of merit for Convergatron stages are the gain-to-feedback ratio G/Γ, and the efficiency, $G(1 - k_{eff})$, where k_{eff} is the effective multiplication constant for a reflected stage (i.e., for $k_{eff} = 1$, G becomes infinite). Specific systems were calculated with a fuel zone assumed to be light-water-moderated ^{235}U with H/U ratio of about 250. For a moderator zone of 4 slowing-down lengths of heavy water, a gain-to-feedback ratio of 13 is achieved with an efficiency of 0.067. The addition of a fission plate at the output side of the fuel region gives no increase in gain to feedback ratio but increases the efficiency by better than 50%. The addition of a light water scattering layer at the input side of the moderator increases the gain to feedback ratio by about 50% and the efficiency by about 10%. By using crystalline moderators at low temperature in conjunction with a light water scattering layer, gain to feedback ratios of better than 100 and efficiencies of the order of 0.2 can be obtained. (Diss. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 17021, 17134, 17315, 17354, and 17392.

17296 (UCRL-16864) DETERMINATION OF THE NEUTRON-NEUTRON SCATTERING LENGTH. Shield, Edward (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 19, 1966. Contract W-7405-eng-48. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Measurements on the reaction T(d,^{3}He)2n at 32.7-MeV incident deuteron energy were used to determine the n-n scattering length. Watson's theory of final-state interactions provides a theory with which the experimental data giving the number of ^{3}He at 6 and 8° vs energy can be compared. Comparison is made with numbers of ^{3}He near the maximum energy, in which case the neutrons go off with little relative energy under the influence of a final-state s-wave interaction. The best fit of the data to theory gives $a_{nn} = -16.1 \pm 0.1$ F. The applicability of this method is proved by measurements on the reaction ^{3}He(d,t)2p, which give a value for a_{pp} equal to the accepted value within the experimental errors. Comparisons of the results with other measurements of a_{nn} are given. (auth)

17297 (UCRL-50178) PHOTON CROSS SECTIONS 1.0 keV TO 15.0 MeV. Plechaty, Ernest F.; Terrall, John R. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 20, 1966. Contract W-7405-eng-48. 112p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Photon cross sections from 1.0-keV to 15.0-MeV photon energy are presented for selected elements in tabular and graphical form together with a discussion of the method of evaluation. (auth)

17298 INFLUENCE OF A ^{4}D COMPONENT IN ^{3}He ON THE D(p,γ)^{3}He DIRECT CAPTURE CROSS SECTION. Bailey, G. M.; Griffiths, G. M.; Donnelly, T. W. (Univ. of British Columbia, Vancouver). Phys. Lett., 24B: 222-4(Mar. 6, 1967).

Inclusion of a small percentage of ^{4}D component in the ground state of ^{3}He is found to modify the direct capture cross section for D(p,γ)^{3}He at low energy. (auth)

17299 SCATTERING OF POLARIZED PROTONS BY DEUTERIUM IN THE ENERGY REGION 10 TO 20 MeV. McKee, J. S. C.; Clark, D. J.; Slobodrian, R. J.; Tivol, W. F. (Univ. of California, Berkeley). Phys. Lett., 24B: 240-2(Mar. 6, 1967).

The polarization of protons elastically scattered from deuterium was measured at four energies between 10- and 20-MeV incident proton energy. The asymmetry is seen to become negative for large angles at 19.1 MeV and for small angles at 11.0 and 13.2 MeV. (auth)

17300 GIANT ELECTRIC DIPOLE RESONANCE IN ^{15}N. Wang, Fleur Belle. Rochester, N. Y., Univ. of Rochester, 1966. 235p.

Thesis.

The electric dipole giant resonance in ^{15}N was considered on the basis of an intermediate coupling shell model. A central two-body potential (V_c) of a Rosenfeld exchange type is assumed between all pairs of nucleons, and a one-body spin-orbit potential ($V_{s.o.}$) is included. The electric dipole radiation widths for even parity energy levels obtained in this calculation exhibit the giant resonance shape. The broad resonance is found to be centered about 19 MeV if the spurious state energy is used as zero reference and to have a width at half maximum of 8 MeV. Analysis of the outstanding peaks in the giant resonance region reveals that these are predominantly excitations of pure j-j configurations. The main contribution to the giant resonances comes from $1p \rightarrow d$ excitations and more specifically from $1p_{\frac{1}{2}} \rightarrow d_{\frac{3}{2}}$. In order to study the role of the residual interaction in the giant resonance, dipole states were constructed in n-p formalism and the interaction expanded in unit-tensor form. It is found that the spin-independent dipole terms in the n-p interaction (V^{np}) determine the energy of the dipole states. In fact, terms for different shells add coherently to give values of the dipole state energy E_D of about 19 MeV. The monopole and spin-independent terms in V^{np}, the like-particle interaction and $V_{s.o.}$ contribute little or nothing at all to the energy. These results and the general structure of the calculation demonstrate that the Goldhaber-Teller collective mode of the giant resonance is contained in the shell model. The width or energy spread of each dipole state depends on both V_c and $V_{s.o.}$. The $V_{s.o.}$ contribution to the width of about the same for each dipole state. But the V_c contribution is proportional to the number of internal excitation states with the same values of J, T as that of the dipole state in question. For the numerical parameters chosen in this work, the width due to $V_{s.o.}$ alone is 1.8 ± 0.5 Mev. The contribution from V_c is ~0.26 MeV times the number of internal excitation states. The giant resonance in ^{16}O was also considered. The results for ^{16}O agree with previous calculations and experiment, while the ^{15}N results are consistent with the expected behavior of light nuclei. Comparison with experiment is discussed for available data. (Diss. Abstr.).

17301 A VARIATIONAL WAVE FUNCTION FOR THE GROUND STATE OF ^{3}He, AND ITS APPLICATION TO THE D(p,γ)^{3}He CAPTURE REACTION. Banville, Marcel-Roland. Vancouver, Can. Univ. of British Columbia, 1965. 166p.

Thesis.

Trial wave functions are proposed for the three-body problem in nuclear physics taking into account the group theoretical classification of the states given by Derrick and Blatt and by Verde. The Schroedinger equation in the internal variables (the interparticle distances), obtained by Derrick from a summation over the matrix elements for kinetic energy and potential energy extended over all variables except the internal variables, is used. An equivalent Schroedinger equation is set up using a potential due to Eckart. This equation has the same form as the original Schroedinger equation in the region outside the range of the nuclear forces. The variables in this equation can be separated in a hyperspherical coordinate system and the resulting separate equations can be solved. Then, using a superposition principle, the solutions of the original equation are expanded in terms of solutions to the equivalent equation. The Rayleigh-Ritz variational procedure is used to determine the coefficients of the expansions with a given potential. Because of the computational labor involved a significant approximation is made in allowing only the leading terms in

the angular variables to appear in the expansions while keeping a sufficient number of radial terms to ensure convergence. The present functions with a radial variable $R = (r_{12}^2 + r_{23}^2 + r_{31}^2)^{0.5}$ give less than 0.5 of the binding energy predicted by Blatt, Derrick and Lyness who used a radial variable $R = r_{12} + r_{23} + r_{31}$. This shows that the approximation with the former radial variable is indeed too crude to predict a reliable value for the binding energy and that more angular terms must be included in the expansions, at least for the preponderant symmetric S-state. Wave functions derived by the Rayleigh-Ritz variational principle are used to calculate cross sections for the reaction $D(p,\gamma)^3He$. The electric dipole cross section depends very sensitively on the potential used to derive the wave function, and a comparison with experimental data provides a test of the various model assumptions used to describe the nuclear interaction. A realistic potential must contain a tensor potential plus a hard core in the central potential. The tensor interaction couples the S and D states and is necessary to explain the quadrupole moment of ^3He while the hard core produced the required mixed-symmetry S-state. The experimentally observed isotropic component of the gamma yield is attributed to a magnetic dipole transition between a continuum quartet S-state and the mixed-symmetry component of the ground state wave function. For a range of the variable parameter used in the calculation comparison with experiment requires a 5% admixture of the mixed-symmetry S-state in the ground state wave function. (Diss. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 17021, 17025, 17046, 17270, 17297, 17317, 17335, 17338, 17340, 17354, 17387, 17391, 17394, 17408, and 17411.

17302 (AECD-TP-17) ALPHA–DEUTERON MODEL AND THE FORM FACTOR OF ^6Li. Ali, Shamsher; Afzal, Syed Ali (Atomic Energy Centre, Dacca (Pakistan)). Sept. 1966. 23p. Dep. mn.

An $\alpha-d$ model of ^6Li was studied in which allowance was made for a distortion of the deuteron wave function by the α particle by minimizing the total energy (i.e., the relative $\alpha-d$ energy plus the internal energy of the deuteron) with respect to the parameters of a suitable trial function for the deuteron. The results indicate that such distortions of the deuteron in ^6Li are probably not very appreciable and lead to a small increase in the binding energy of the ground state. The form factor of ^6Li was calculated with this model and was found to be fairly satisfactory within the limitations of the approach. The adequacy of the model is also discussed. (auth)

17303 SHAPE OF THE FOUR-PARTICLE, FOUR-HOLE STATE OF ^{16}O. Stephenson, G. J. Jr.; Banerjee, M. K. (Univ. of Maryland, College Park). Contract AT(40-1)-3491. Phys. Lett., 24B: 209-12(Mar. 6, 1967).

Consideration of the interaction between the p shell and the s-d shell particles, coupled with the short-range character of the nuclear force, leads to the conclusion that the 4-particle, 4-hole state of ^{16}O should have ellipsoidal symmetry. A simple Hartree-Fock calculation bears this out. (auth)

17304 ELASTIC SCATTERING OF DEUTERONS FROM CARBON AT 420 MeV. Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Lett., 24B: 229-31(Mar. 6, 1967).

Employing Glauber's approximation and optical potential, the angular distribution and vector and tensor polarization for the scattering of 420-MeV deuterons from carbon are calculated and are compared with the experimental data of Button and Mermod. (auth)

17305 STUDY OF THE GIANT RESONANCE OF LIGHT AND HEAVY NUCLEI BY SCATTERING OF BREMSSTRAHLUNG. Loiseaux, J.-M.; Maison, J.-M.; Langevin, M. (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 28: 11-20(Jan. 1967). (In French).

The differential photonuclear scattering cross sections were measured in the giant resonance region for the nuclei ^9Be, ^{10}B, ^{11}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F, ^{23}Na, ^{24}Mg, ^{28}Si, ^{32}S, ^{39}K, ^{40}Ca, ^{55}Mn, ^{56}Fe, and ^{59}Co. For many of these nuclei, some levels or groups of levels are observed above the giant resonance region at about 28 to 30 MeV. Angular-distribution measurements allowed the estimation of the inelastic scattering contribution to the first 2^+ level of the nuclei ^{24}Mg, ^{28}Si, and ^{56}Fe. These measurements indicate a strong interference of the different spin states of levels excited by dipole transition for ^{39}K and above 25 MeV for ^{23}Na. (auth)

17306 NEW DATA ON THE INTERACTION OF HIGH-ENERGY PROTONS WITH CARBON NUCLEI. Bayukov, Yu. D.; Vorob'ev, L. S.; Kolybasov, V. M.; Leksin, G. A.; Stolin, V. L.; Fedorov, V. B.; Khovanskii, V. D. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 337-40(Feb. 1967). (In Russian).

The polarization of protons emitted by the C nucleus at an angle of 137° in the laboratory system was observed for 2- and 3.66-GeV initial protons. The presence of the polarization and a comparison of the proton and deuteron spectra, measured at the same angle, in the energy region 1.15 to 5.7 GeV, with calculations based on an α-particle transfer pole diagram, give evidence in favor of the pole mechanism of direct nuclear processes. (auth)

17307 ABSOLUTE MEASUREMENTS OF THE ELASTIC SCATTERING OF 100 AND 200 MeV ELECTRONS ON THE ^{12}C NUCLEUS. Afanas'ev, N. G.; Kovalev, V. D.; Omelaenko, A. S.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G. Yadern. Fiz., 5: 318-26(Feb. 1967). (In Russian).

An experimental device for the investigation of high energy electron scattering on nuclei is described. An absolute measurement of the ^{12}C nuclear form factor is carried out with an accuracy ±10% in the region of momenta 0.176 to 1.55 f^{-1}. Data on the mean-square and mean fourth-power radii, obtained by fitting the form factor from the "generalized shell model" of the charge distribution in the nucleus to the experimental data and by a model-independent method, are compared. (auth)

17308 CHARGE EXCHANGE OF STOPPED MESONS (π^-) ON LIGHT NUCLEI. Petrukhin, V. I.; Prokoshkin, Yu. D.; Filippov, A. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 327-9(Feb. 1967). (In Russian).

The charge-exchange probability was measured for mesons (π^-) stopped on ^3He nuclei. The charge-exchange probability for mesons (π^-) at rest on ^{10}B, ^{14}N, and ^{35}Cl was found to be $<10^{-4}$. (auth)

17309 THEORY OF DECAY OF ^{12}C INTO THREE α PARTICLES. Zickendraht, W. (Univ., Marburg, Ger.). Z. Phys., 200: 194-204(1967). (In German).

A complete orthogonal system derived in an earlier paper is used to analyze the Dalitz diagram for the three α particles in the decay of ^{12}C. The hypothesis that only few of these orthogonal functions will be of importance is confirmed. (auth)

17310 STUDY OF THE REACTIONS (d,p) ON ^{14}N AT $E_d \leq 2.2$ MeV. Beaumevieille, H.; Lambert, M.; Yaker, M.; Amokrane, A. (Institut d'Etudes Nucleaires, Algiers). Nuovo Cimento (10), 47B: 139-55(Feb. 11, 1967). (In French).

The differential cross sections of the reaction $^{14}N(d,p)^{15}N$ were measured for six proton groups at deuteron energies of 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, and 2.2 MeV. Theoretical fits were made to the differential cross sections corresponding to transitions of different l_n using Butler theory and the theory of Coulomb stripping. The results indicate that (d,p) reactions with low Q values proceed by direct interaction. (D.C.W.)

17311 DEFORMED EXCITED STATES IN CLOSED SHELL NUCLEI. Eichler, Joerg; Marumori, Toshio (Univ. of Copenhagen). Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 7, 1-56(1966).

A systematic theory of treating the complex ground-state correlations for 2particle-2hole excitations is proposed. It is shown that these new ground-state correlations describe the collective predisposition of the spherical ground state in closed-shell nuclei to produce deformed excited states. The resulting deformation of the excited states incorporates the deformation of the core. These features are made evident by a self-consistent method. Formal properties of the solutions and their influence on various electromagnetic transitions are discussed. (auth)

17312 ^8Be LEVELS AT 16.62, 16.92, AND 19.9 MeV FROM $^6Li(^6Li,\alpha)^8Be$. Mancusi, Michael D. Iowa City, Iowa, Univ. of Iowa, 1966. 56p.

Thesis.

Angular correlations in the reaction plane for the 16.62- and 16.92-MeV, $J^\pi = 2^+$ states in ^8Be were measured for the reaction $^6Li(^6Li,\alpha_1)^8Be^* \rightarrow 2\alpha$ at a bombarding energy of 5.5 MeV with α_1 detected at 15° in the laboratory system. The correlations for the two states are identical to a multiplicative factor at all decay alpha angles. Another alpha-alpha coincidence run at 5.0-MeV bombarding energy was performed to measure the ratio of intensities of these two states. The same data show the 19.9-MeV ^8Be state to have a measured width of 1.3-MeV. In addition, measurements of the ratio of the differential cross sections of the 16.62- and 16.92-MeV levels over a range of bombarding energies from 4.3- to 5.5-MeV indicate that the relative intensity of the 16.62-MeV level to that of the 16.92-MeV level is a constant equal to 1.20 ± .08. These results compare favorably with

a description of these states as strongly mixed in isobaric spin. (Dissertation Abstr.)

17313 THE $^{13}C(^3He,\alpha)^{12}C$ REACTION. Kellogg, Edwin Manville. Philadelphia, Univ. of Pennsylvania, 1966. 123p.

Thesis.

A study of the $^{13}C(^3He,\alpha)^{12}C$ reaction was undertaken in order to learn more about the structure of the excited nuclear states of ^{12}C and of the ground state of ^{13}C. In order to apply distorted-wave analysis, the elastic scattering angular distribution of ^3He on ^{13}C was measured at the Pennsylvania Tandem Accelerator, using 90% enriched ^{13}C target. The ^3He particles were identified by a telescope of solid-state detectors. The HUNTER program was used to find a set of optical parameters which fit the data at all three energies, with only a slight negative energy dependence of the real well depth, V, and positive energy dependence of the imaginary well depth, W. A spin-orbit term was also found necessary. Angular distributions of alpha particles were taken, using a set of eight silicon surface-barrier detectors. The following states in ^{12}C were measured: ground, 4.433, 7.656, 9.64, 10.84, 11.83, and 12.71 MeV. The DWBA (JULIE) analysis shows pickup of l = 1 or 0 for all except the 9.64-MeV state, where l = 2 is found. There is some indication of j-dependence. The spectroscopic factors are extracted and discussed. (Dissertation Abstr.)

17314 ANGULAR DISTRIBUTIONS FROM THE $^6Li(^6Li,n)^{11}C$ REACTION AT 4.10 MeV. Bahnsen, Robert Montgomery. Iowa City, Iowa, Univ. of Iowa, 1966. 92p.

Thesis.

A computer-based time-of-flight system was used to study the angular distributions from the $^6Li(^6Li,n)^{11}C$ reaction at 4.10 MeV bombarding energy. Groups from the ^{11}C 2.00, 4.32, 4.81, 6.35/6.49, 6.90, and 7.50 MeV states were observed. A 10-inch diameter × 2-inch thick plastic scintillator was used as the neutron detector, and the length of the flight-path was 2 meters. Associated γ rays were used for stop triggering. All groups except the 6.4 MeV doublet were adequately resolved. The distributions were taken with plastic detectors in both the start and stop channels and normalized at one angle using NaI(Tl) as the γ-ray detector with corrections for efficiency made on the basis of the measured branching ratios of ^{11}C. The results were compared with data from the mirror $^6Li(^6Li,p)^{11}B$ reaction taken at the same energy. Angular distributions from the 2.00, 4.32, 4.81, and 6.35/6.49 MeV states were quite similar to the distributions from the mirror levels in ^{11}B, and the relative total cross sections agreed to within 10%. Agreement for the ^{11}C 7.50 MeV state and its mirror in ^{11}B was not quite so good—the total cross sections differed by 15%. Relatively poor agreement was found for the ^{11}C 6.90 MeV state and its mirror in ^{11}B. The total cross sections differed by 40%. An additional group from the 8.43 (second unbound) state of ^{11}C was observed with an intensity of 10% of that for the 7.50 MeV state. Previous studies have not reported γ decay from this level. Arguments are presented to show that this level must be a single-particle state of extreme purity. No evidence for the γ decay of the 8.10 MeV state was found; therefore γ-decay intensity from it is taken to be <2% of the 7.50 MeV state. (auth)

17315 STUDY OF THE COMPOUND NUCLEUS ^7Be. Harrison, William Douglas. Pasadena, Calif., California Inst. of Tech., 1966. 197p.

Thesis.

Measurements were made of the differential cross section for the $^6Li(p,p)^6Li$ and $^6Li(p,p')^6Li$ (2.184 MeV) reactions, of both the differential and the total cross section for the $^6Li(p,p'')^6Li^{**}$(3.562 MeV) reaction, and of the total cross section for the $^4He(^3He,p'')^6Li^{**}$ reaction. The ranges of incident particle laboratory energies were from 2.4 to 12.0 MeV, 3.6 to 9.4 MeV, 4.3 to 9.4 MeV, and 13.8 to 18.4 MeV, respectively. Other measurements were made to determine the consistent relative normalization of these data and the data obtained by other investigators on ^7Be-forming reactions, and to determine the correct overall absolute normalization. The $^6Li(p,p)^6Li$ data indicate the existence of a broad state at about 10-MeV excitation energy in ^7Be and the possible existence of extremely broad structure at roughly 13 MeV, but do not support the existence of a proposed state at 14.6 MeV. The $^6Li(p,p')^6Li^*$ data indicate that the broad state is located at about 10.0 MeV and has a width of about 1.8 MeV. This is consistent with the $^6Li(p,p'')^6Li^{**}$ and $^4He(^3He,p'')^6Li^{**}$ data. These data exhibit an interference-like feature, which has been associated with the existence of another ^7Be state located at about 11.0 MeV and with a total width of about 0.4 MeV. On the basis of an analysis with complex eigenvalue resonance theory the assignments $J^\pi = \frac{3}{2}^-$ for both the 10.0- and the 11.0-MeV states were made, and the existence of an extremely broad $J^\pi = \frac{1}{2}^-$ state at roughly 10 MeV or higher was suggested. The isotopic spin assignments $T = \frac{1}{2}$ for the 10.0-MeV state and $T = \frac{3}{2}$ for the 11.0-MeV state were made. Possible values for some of the partial widths, the results of other experiments, and the evidence relating to the usefulness of different versions of complex eigenvalue theory are discussed. (Diss. Abstr.)

17316 SPECTRA CALCULATIONS FOR THE POSITIVE PARITY STATES OF EVEN-EVEN NUCLEI IN THE 2s,1d SHELL. Stover, Joe Earl. Austin, Tex., Univ. of Texas, 1966. 134p.

Thesis.

The nuclear states are classified according to the irreducible representations of SU_3, and a systematic method of evaluating energy matrix elements in the SU_3 classification scheme of Elliott is illustrated. This method is applied to calculate the positive-parity states for even-even nuclei in the 2 sld shell corresponding to the lowest-lying irreducible representations of SU_3. A Yukawa interaction potential with Serber mixing is used, and the parameters in this potential are adjusted to fit the experimentally observed spectra. Calculations for the low-lying energy levels of ^{18}O, ^{20}Ne, ^{22}Ne, ^{24}Mg, ^{26}Mg, ^{28}Si, ^{30}Si, ^{32}S, ^{34}S, ^{36}Ar, and ^{38}Ar are compared to experimental data. (Diss. Abstr.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 15939, 15971, 15981, 17021, 17270, 17297, 17308, 17316, 17338, 17340, 17354, 17387, 17393, 17394, 17408, 17411, and 17422.

17317 (AD-640270) BIBLIOGRAPHY OF TRITON INDUCED REACTIONS. Owen, David (Naval Research Lab., Washington, D. C.). Aug. 1965. 35p. (NRL-Bib-28). CFSTI $3.00 cy, $0.65 mn.

Summaries are given of the articles published on triton-induced reactions between 1961 and 1965. Also included are author and subject indexes to increase the utility of the bibliography. (auth)

17318 (AECL-2659) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1-DECEMBER 31, 1966. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 76p. (PR-P-72). Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $2.00.

Levels in ^{25}Mg up to 4 MeV and in ^{26}Mg to about 6 MeV were excited by inelastic scattering of protons from the MP tandem accelerator. Proton bombarding energies between 3.8 and 8.3 MeV were chosen to populate the state under study directly without gamma cascades from higher states. The gamma rays were detected in a 25-cm^3 Ge(Li) spectrometer, and lifetimes were measured by observing attenuated Doppler shifts at angles between 20 and 160°. Information on decay schemes was also obtained. Measurements on the first four levels in both ^{25}Mg and ^{26}Mg were completed, and further measurements on higher levels in both nuclei are continuing. A three-crystal pair spectrometer consisting of a 25-cm^3 Ge(Li) detector surrounded by two NaI(Tl) scintillation detectors was constructed for studies using the tandem accelerator. A single peak is obtained for a high-energy γ ray by selecting pulses in the Ge(Li) detector which are in triple coincidence with the 511-keV annihilation peaks in the NaI(Tl) detectors. The apparatus was tested using collimated RdTh (2.62 MeV) and ^{88}Y (1.836 MeV) γ-ray sources. Approximately 20% of the "double-escape" peaks in the Ge(Li) spectrum are recorded in triple coincidence, and the remaining part of the spectrum is greatly reduced giving an improvement in the peak value to background ratio of about 50. The C5 triple-axis neutron spectrometer was used in a program to investigate the temperature dependence of the anharmonic shifts and half-widths of phonon frequencies in a single crystal of potassium. Measurements were made at 9, 92, 215, and 299°K. In all, 150 modes were studied, and for some of them the shifts and half-widths at high temperatures were an appreciable fraction of the frequency at 9°K. Theoretical calculations of the anharmonic shifts and widths of phonons in potassium as a function of temperature were also made. The processes causing these anharmonic effects are as follows: A phonon may be scattered into two other phonons due to third order terms in the potential between atoms in the potassium metal; this gives rise to a lowering of the phonon frequency and a width due to the finite lifetime of the phonon. A phonon may interact with any other phonon present in the crystal through the fourth order potential; this gives rise to a frequency shift which may be either positive or negative. Finally, a lowering of the frequency is produced by a uniform strain in the lattice arising from the thermal expansion. The anharmonic coefficients required for the calculation were obtained from a total potential of a pseudo-atom model fitted to the phonon frequencies at measurements of 9°K. For several phonons there is good agreement between theory and experiment for the shifts up to 215°K, but not at room temperature where it is known that many vacancies are present in the

crystal and where multi-phonon scattering becomes appreciable. Agreement is generally poor for the phonon half-widths, and this probably indicates an inadequacy in the model used in calculations. Lattice vibrations were shown to influence the electronic band structure of crystals. Within the pseudopotential model, the leading correction to normal band structure calculations with fixed ions is to multiply the pseudopotential coefficients by the appropriate Debye–Waller factors. This tends to reduce the effect of the crystal structure on the electron bands, so that solids will tend to be more free-electron-like at high temperatures, in agreement with measurements of the Hall effect in metals. These effects will be particularly marked in those crystals for which the electron bands are greatly influenced by the crystal structure, such as transition metals and narrow band gap semiconductors. The effects might be seen in detail by a change with temperature in the Fermi surface shape or the position of the Kohn anomaly. Detailed calculations based on a published pseudopotential model were made of the temperature dependence on the band gap in Ge and Si. The results are 4.3×10^{-4} eV/°K and 4.1×10^{-4} eV/°K, respectively, whereas published measurements give 3.9×10^{-4} eV/°K and 2.4×10^{-4} eV/°K. The agreement reflects limitations in the assumed model. A triple axis crystal spectrometer was put into operation at the hole C4 of the NRU reactor. The in-pile collimator contains a 5 in. single crystal quartz filter cooled to liquid nitrogen temperature to provide an improved ratio of slow to fast neutrons. The spectrometer is designed with a fixed monochromator angle but a good selection of incident neutron energies may be obtained by using different monochromator crystals and crystal planes. Due largely to the lower neutron flux at C4, the intensity of monochromatic neutrons incident on the specimen in this spectrometer is about 1/8 that in the C5 spectrometer. However, with its low background rate this spectrometer will be an important supplement to the C5 spectrometer. Modifications were made to both G-20 and 3100 operating systems to have the first pass of the APEX compiler executed by the 3100 before the program is submitted to the G-20. Programs were written for use in the G-20 computer as follows: a program for drawing PERT networks on a CALCOMP plotter, a program which compares the decay of irradiated foils with the decay curve of a standard foil, a program to analyze body monitor data and to plot contour and relief pictures of the scanned body, a program to calculate the matching of charged particle beams with magnetic transport systems consisting of certain symmetric arrangements of quadrupole lenses, and a program to calculate a geometric factor for the self-absorption in a two-shell cylindrical fuel element. (auth)

17319 (BMwF-FBK-66-37) EINE APPARATUR ZUR MESSUNG VON GAMMA-GAMMA-LINEARPOLARISATIONSRICHTUNGSKORRELATIONEN. (An Apparatus for the Measurement of Gamma-Gamma-Linear Polarization Correlations). Huebel, H. (Bonn Univ. (West Germany). Institut fuer Strahlen und Kernphysik). Nov. 1966. 66p. (In German). Dep. mn.

A survey of the results of the theory of gamma–gamma angular correlations and gamma–gamma linear polarization correlations are given. The Compton effect is used for the measurement of the linear polarization of gamma rays. The nine-detector apparatus employed, the analysis of the data, and the calibration of the apparatus by measurements on ^{60}Co and ^{46}Sc, as well as the calculation of the asymmetry ratio, R, are described. The parity of the 1543-keV level in ^{166}Er was determined. (auth)

17320 (KFK-434) MESSUNG DER $\beta-\gamma$-ZIRKULARPOLARISATIONSKORRELATION AN ERLAUBTEN β-UEBERGAENGEN. (Measurement of the $\beta-\gamma$ Circular Polarization Correlation in Allowed β Transitions). Behrens, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). June 1966. 169p. (In German). Dep. mn.

With a new type of apparatus used for the measurement of the $\beta-\gamma$ circular polarization correlation in which the magnet was used not only as a scattering magnet for the circularly polarized γ quanta but also as a β spectrometer, a quadrupling of the installation could be obtained with respect to the conventional types of apparatus and the statistical and systematic errors could be greatly reduced. The analyzer efficiency was calculated with all correctors and a control. The assymetry coefficients of the $\beta-\gamma$ circular polarization correlation of ^{110}Ag, ^{41}Ar, ^{47}Ca, ^{134}Cs, ^{56}Co, ^{58}Co, ^{60}Co, ^{52}Mn, ^{56}Mn, ^{22}Na, ^{24}Na, ^{46}Sc, and ^{48}V were determined. (tr-auth)

17321 (NP-16589) SHELL MODEL CALCULATIONS IN CALCIUM ISOTOPES. Osnes, Eivind (Oslo Univ., Blindern (Norway). Fysisk Institutt). Apr. 1966. 172p. Dep. mn.

Thesis.

An attempt to describe Ca isotopes using the shell model is summarized. A many-particle shell model is outlined, and the results of calculations of binding energies and excitation energies using both pure configurations and configuration mixing are presented. The theoretical predictions are compared with experimental values. The solution of the quantum-mechanical many-body problem is stressed. (D.C.W.)

17322 (ORNL-TM-1753) INELASTIC SCATTERING OF 40-MeV POLARIZED PROTONS. Fricke, Martin P. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 143p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Univ. of Minnesota, Minneapolis.

The left-right asymmetry and differential cross section for the inelastic scattering of 40-MeV polarized protons were measured over a large angular region for each of the following 2^+ excitations: 1.78 MeV in ^{28}Si, 1.41 and 2.97 MeV in ^{54}Fe, 1.45 MeV in ^{58}Ni, and 1.33 MeV in ^{60}Ni. Some asymmetry and cross-section data were also obtained for 3^- states: 6.9 MeV in ^{28}Si, 4.8 and 6.4 MeV in ^{54}Fe, 4.5 MeV in ^{58}Ni, and 4.08 MeV in ^{60}Ni. Elastic polarization and cross-section data were obtained for each target. The inelastic scattering was analyzed in the distorted-wave approximation using the collective-model extension of the optical-model potential determined by fitting the elastic scattering. The inelastic asymmetry and cross-section data are best reproduced with a collective-model interaction obtained by deforming the complete optical potential, including its imaginary and spin-orbit parts. (auth)

17323 (UJV-1705) INVESTIGATION OF THE GAMMA-RAY SPECTRUM FROM THE RESONANCE NEUTRON CAPTURE IN ^{35}Cl. Becvar, F.; Honzatko, J.; Kosina, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Nov. 1966. 10p. Dep. mn.

Using the fast chopper and the scintillation spectrometer, the spectrum of the gamma rays following the resonance neutron capture at 405 eV in ^{35}Cl was measured. Analysis of the spectrum was performed. The strengths of some primary transitions are given. The resonance state $J^\pi = 0^-$ was excluded. (auth)

17324 EXCITATION OF SIMPLE CONFIGURATIONS IN THE OUTGOING REACTION CHANNEL. Ballini, R.; Cindro, N.; Delaunay, J.; Fouan, J. P.; Loret, M.; Passerieux, J. P. (CEN, Saclay, France). Phys. Rev. Lett., 18: 408-11(Mar. 13, 1967).

Proton-gamma coincidence spectra from the ^{40}Ca(p,p'γ)^{40}Ca reaction were measured gating both with all gamma transitions and with only corresponding ground-state transitions. The selective excitation of states associated with simple configurations in the residual nucleus was observed in inelastic scattering with ground-state gamma transitions. (D.C.W.)

17325 INVESTIGATION OF THE FRAGMENTATION EFFECT FOR 2 TO 9 GeV PROTONS. Gorichev, P. A.; Lozhkin, O. V.; Perfilov, N. A. Yadern. Fiz., 5: 26-33(Jan. 1967). (In Russian).

All the basic quantities (the cross section, energy spectra, angular distributions, charge distributions, dependence of the fragment production probability on the energy transfer to the target nucleus, etc.) characterizing the production of ^{8}Li, Be, B, and C fragments, in the disintegration of Ag and Br emulsion nuclei by 2-, 3-, 6-, and 9-GeV protons and Ta and Pb nuclei by 9 GeV protons, are determined by means of the nuclear photoemulsion method and the emulsion chamber with foils. (auth)

17326 EXPERIMENTAL INVESTIGATION OF THE RESONANCE SCATTERING OF 1 TO 2 MeV NEUTRONS ON Fe NUCLEI. Guseinov, A. G.; Orlov, V. V.; Popov, V. I.; Suvorov, A. P.; Trykova, V. I. Yadern. Fiz., 5: 255-6(Feb. 1967). (In Russian).

The angular distributions of neutrons elastically scattered on iron were measured using neutrons previously transmitted through iron filters. The measurements were performed using threshold scintillation detectors for 1 to 2 MeV neutrons. An attempt was made to separate the angular distribution of elastically scattered resonance neutrons by analyzing the differential cross-sections obtained with and without a filter. This distribution proved to be almost symmetrical with respect to 90°. (auth)

17327 POLARIZATION EFFECT IN THE HYPERFINE STRUCTURE OF ^{65}CuI,$3d^9 4s^2 m^2 D$. Fischer, Wolfgang; Huehnermann, Harry; Kollath, Klaus-Johannes (Univ., Marburg, Ger.). Z. Phys., 200: 158-64(1967). (In German).

The hyperfine structure of the transition ^{65}Cu I, $3d^{10}4p^2P_{\frac{3}{2}} - 3d^9 4s^2 m^2 D_{\frac{5}{2}}$ was investigated by optical interferometric methods. For the hfs factors, the following values were found: A(^{65}Cu, $m^2D_{\frac{5}{2}}$) = 26.79(3) mK and B(^{65}Cu, $m^2D_{\frac{5}{2}}$) = 5.81(10) mK. The core polarization of the m^2D terms and the Sternheimer corrections in the calculation of the quadrupole moment of ^{65}Cu from the B-factors of the terms $3d^9 4s^2 m^2 D$ and $3d^{10}4p^2P_{\frac{3}{2}}$ were discussed. (auth)

17328 DECAY OF ^{61}Cu. Schoeneberg, R.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 200: 205-12(1967). (In German).

The γ spectrum of ^{61}Ni associated with the electron-capture and β^+ decay of ^{61}Cu was measured with a Ge(Li) counter. The 14 previously unreported γ-ray transitions led to a new level scheme for this decay with ^{61}Ni levels at: 67.7, 282.9, 656.0, 907.9, 1099.8, 1132.7, 1186.8, 1610.6, 1730.8, and 2128.0 keV. Five of these levels were known from earlier investigations of ^{61}Cu decay, but all of them could be identified with some of previously reported levels found in scattering experiments. As far as possible, spin and parity assignments were made and are compared with the results of scattering experiments. (auth)

17329 LEVEL STRUCTURE OF ^{48}Sc FROM THE ^{50}Ti(d,α)^{48}Sc REACTION. Grotowski, K. (Instytut Fizyki Jadrowej, Krakow); Wiktor, S.; Pellegrini, F. Nuovo Cimento (10), 47B: 255-62 (Feb. 11, 1967).

The ^{50}Ti(d,α)^{48}Sc reaction was investigated using deuterons with an energy of 12.9 MeV. Energy spectra and angular distributions of α-particles emitted in this reaction were measured. Relatively large cross sections were found for transitions leading to the 0.14-, 1.06-, and 2.03-MeV excited states of the residual ^{48}Sc nucleus. The spin and parity values suggested for the 0.14-MeV state and the previously unobserved 1.06-MeV state are $J^\pi = 5^+$ and $J^\pi = 7^+$, respectively. (auth)

17330 ^{22}Ne(d,p)^{23}Ne ANGULAR DISTRIBUTIONS AT E_d = 3 MeV FOR THE FIRST EXCITED LEVELS OF ^{23}Ne. Dumazet, G.; Beaumevieille, H.; Lambert, M.; Meynadier, C. (Institut d'Etudes Nucleaires, Algiers). Nuovo Cimento (10), 47B: 294-6(Feb. 11, 1967).

The angular distributions of several proton groups from the reaction ^{22}Ne(d,p)^{23}Ne at 3 MeV were measured. The angular momentum transfer of the captured neutron was determined using Butler theory. Spin-parity assignments were made to several energy levels of ^{23}Ne. (D.C.W.)

17331 DIRECTIONAL GAMMA–GAMMA CORRELATION IN A POLYCRYSTALLINE SOURCE ^{46}Sc. Gadjokov, V.; Enchev, D.; Misheva, M.; Toumbev, G. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 15: 67-71(1966). (In Russian).

A directional correlation function was measured for the cascade 4^+ (E2, 1.119 MeV) 2^+(E2, 0.887 MeV)0^+ in a ^{46}Sc polycrystalline source. An attenuation of the correlation coefficients was observed. Some of the possible perturbing factors are discussed. (auth)

17332 STRUCTURE OF THE GIANT RESONANCE OF ^{24}Mg. Titze, O.; Spamer, E.; Goldmann, A. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 24B: 169-71(Feb. 20, 1967).

In electron scattering experiments ($E_e \approx 45-54$ MeV, $\theta = 129°-153°$) previously unresolved resonances were resolved in the giant resonance region of ^{24}Mg. The energies of 24 transitions are given. (auth)

17333 ANALOG STATES IN ^{39}Ar OBSERVED WITH THE ^{40}Ar(^{3}He,α)^{39}Ar REACTION. Greene, M. W. (Univ. of Iowa, Iowa City). Phys. Lett., 24B: 171-2(Feb. 20, 1967).

Two alpha-particle groups from the ^{40}Ar(^{3}He,α)^{39}Ar reaction corresponding to excitation energies of 9089 ± 20 keV in ^{39}Ar identify isobaric analog states of the ^{39}Cl ground and first excited states. (auth)

17334 INVESTIGATION OF Kx–γ DIRECTION CORRELATION IN THE DECAY OF ^{54}Mn. Perepelkin, V. V. (Leningrad Mechanical Inst.). JETP Lett. (USSR) (Engl. Transl.), 5: 81-2(Feb. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 99-101(Feb. 1, 1967).

An attempt was made to study Lx–γ correlations, but it was found that the measurement of Lx–γ correlations is hindered by the background from the K x rays. Coincidences between the K x rays and the gamma rays were then investigated; the existence of Kx–γ correlations was demonstrated. (D.C.W.)

17335 PRODUCTION OF TRITIUM ON C, Al, AND Fe BY 130 TO 660 MeV PROTONS. Mekhedov, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 34-6(Jan. 1967). (In Russian).

The cross sections for the production of tritium on carbon, aluminum, and iron were measured for several proton energies between 130 and 660 MeV. The cross sections on carbon are 7.4 ± 1, 10.1 ± 1.5, and 10.6 ± 1.7 mb (for E_p equal to 450, 550, and 660 MeV). For aluminum they are in the interval between 15 ± 2.6 and 42 ± 6 mb (E_p = 130 to 660 MeV). On iron the cross sections are equal to 6.4 ± 1.5 and 34 ± 8 mb at 130 and 450 MeV, respectively. (auth)

17336 DIFFERENTIAL ELASTIC SCATTERING OF 3.15 MeV NEUTRONS BY Al, S, V, AND Co. Lambert, Roy Anthony. Baton Rouge, La., Louisiana State Univ., 1966. 73p.

Thesis.

The differential elastic cross sections of Al, S, V, and Co for 3.15-MeV neutrons were measured by the time-of-flight technique. The particular version of this method was velocity determination of the scattered neutrons by pulsed beam utilizing a Van de Graaff generator to produce neutrons by means of the D(d,n)^{3}He reaction. Beam pulsing is accomplished with a Mobley variable-path magnetic ion buncher. The spread in energy of the neutron beam was ±0.15 MeV, and the burst duration was 2.5 nanoseconds. Measurements were made at 10° intervals from 20 to 140° over a 125-cm flight path. Scattering material was in the form of right circular cylinders. The detector is a stilbene crystal mounted on a 56AVP photomultiplier mounted in a shield containing paraffin and lithium carbonate for neutron attenuation as well as lead to stop gamma photons. Photomultiplier pulses are processed in a time-to-pulse-height converter which feeds them to a TMC 400-channel analyzer. The energy resolution was 14.5%. The raw data were converted into absolute cross sections by normalizing to the direct beam count at 0°. The angular distributions so obtained are compared to published values at nearby energies and to the general predictions of optical-model theory. A check of the 0° cross section was also made by means of Wick's limit. The results are seen to be generally in good agreement with expected values. (Dissertation abstr.)

17337 INVESTIGATION OF ^{41}K BY PROTON-INDUCED REACTIONS ON ^{40}Ar. Slivinsky, Vincent William. University Park, Pa., Pennsylvania State Univ., 1966. 72p.

Thesis.

Bernard and Kim have studied the ^{40}Ar(p,p$_0$)^{40}Ar, ^{40}Ar(p,p'γ)^{40}Ar, and ^{40}Ar(p,α_0)^{37}Cl reactions with incident proton energies between 1.8 and 3.55 MeV. Anomalous behavior was found in the inelastic cross section at 1.88, 2.45, and 3.40 MeV. The purpose of this investigation was to continue the excitation curves for proton-induced reactions from 3.5 to 6.0 MeV in search of new anomalies. Protons from the Pennsylvania State University 5.5-MeV Van de Graaff accelerator were used for this experiment. A scattering chamber was constructed and filled with 99.9998% pure natural argon to a pressure of a few millimeters of mercury. A nickel foil, .000025 inches thick, separated the argon gas from the accelerator tube. Excitation curves were taken for the (p,p$_0$), (p,p$_1$), (p,p$_2$), (p,p$_3$) and (p,α_0) reactions. Little information was obtained from the elastic scattering data because of strong overlapping of the resonances. However, strong excitations were observed in the (p,p$_2$) cross section especially at 4.56, 4.58, 4.63, 4.99, 5.03, 5.07, and 5.24 MeV. Some of these anomalies had corresponding large peaks in the (p,p$_1$) and (p,p$_3$) reaction data. A correlation was found between these anomalous peaks and their "analogue states" in ^{41}Ar. Ericson's fluctuation theory was applied to the (p,α_0) excitation curve yielding an average width, $\Gamma = 3.9 \pm .9$ keV, and an average lifetime, $\tau = (1.7 \pm .4) \times 10^{-19}$ sec, for the states in ^{41}K at an excitation energy of 12.3 to 13.5 MeV. This experiment was unusual in two respects. In a region of many overlapping levels, Γ was calculated from an experimental excitation curve where $\Gamma <$ the beam resolution. Excitation peaks for two different reactions leading to the same compound nucleus were interpreted as being due to individual states in one case and fluctuations in the other. (Diss. Abstr.)

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Refer also to abstracts 15878, 15914, 15915, 16244, 17021, 17270–17272, 17286, 17297, 17317, 17318, 17320, 17325, 17411, 17416, and 17422.

17338 (AD-647225) INELASTIC NEUTRON SCATTERING CROSS SECTIONS IN SEVERAL ELEMENTS WITH 15 MeV NEUTRONS. Mathur, Suresh C.; Buchanan, Patricia S.; Morgan, I. L. (Texas Nuclear Corp., Austin). Jan. 1967. Contract DA18-035-AMC-363(A). 172p. (NDL-TR-86). CFSTI $3.00 cy, $0.65 mn.

Differential cross sections for neutron inelastic scattering by Sb, Be, B, ^{10}B, Cd, C, Ce, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, Se, Si, Ti, W, V, and Y at 15 MeV were measured using time-of-flight techniques. The cross sections were corrected for double scattering using the MULTISCAT code, which was developed to calculate corrections for multiple scattering. (D.C.W.)

17339 (AE-266) THE HALF LIFE OF THE 53-keV LEVEL IN ^{197}Pt. Malmskog, S. G. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1967. 8p. Dep. mn.

The half life of the recently proposed 53-keV level in ^{197}Pt was measured to be 18.5 ± 1.5 nsec using the delayed coincidence technique. This level, which is identified with the $f_{\frac{5}{2}}$ single-particle state, decays directly to the $p_{\frac{3}{2}}$ ground state in ^{197}Pt. The reduced E2 transition probability for this 53-keV transition

was deduced and was compared with the results obtained for the corresponding transitions in other Pt, Hg, and Pb isotopes and with the theoretical predictions by Sorensen and by Wahlborn and Martinson. (auth)

17340 (AEET-267) PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN INDIA: III. (Atomic Energy Establishment, Trombay (India). Nuclear Physics Div.). Aug. 1966. 69p. Dep. mn.

Total cross sections for the reaction $^{16}O(n,\alpha)^{13}C$ were obtained from total cross sections for the reactions $^{13}C(\alpha,n)^{16}O$; ^{17}O level widths were also determined. The angular and energy distributions of fission fragments from the neutron fission of ^{235}U were measured, as were neutron resonance parameters for ^{197}Au, ^{165}Ho, ^{109}Ag, and ^{181}Ta. Isomeric cross-section ratios for (n,γ) reactions on ^{77}Ge and ^{82}Se were measured using a radiochemical method; and neutron total cross sections, scattering cross sections, and scattering angular distributions were calculated for the energy range 0.1 to 4.0 MeV using the optical and statistical models. The reactions $^{51}V(p,\alpha)$ and $^{51}V(p,n)$ were also investigated, together with proton elastic and inelastic scattering by ^{51}V. The spins of levels in ^{25}Mg and ^{27}Mg were obtained from p-γ angular correlation measurements on the reactions $^{24}Mg(d,p\gamma)^{25}Mg$ and $^{26}Mg(d,p\gamma)^{27}Mg$. Excitation functions for alpha elastic scattering by ^{6}Li and ^{24}Mg were measured; resonances corresponding to levels in ^{10}B and ^{28}Si were observed. The differential cross section for the reaction $^{40}Ca(He-3,p)^{42}Sc$ was calculated, and the lifetimes of the 1.10- and 1.29-MeV states of ^{59}Co were measured. The intensity of the 1.114-MeV γ transition in the decay of ^{65}Zn was measured; and experimental values of the thermalization and diffusion parameters of Pb were obtained, while similar parameters were claculated for BeO. Cold neutron scattering by liquid CD_4 and CH_4 was investigated, together with lattice vibrations of V and the phonon spectrum of Mg. A neutron diffraction spectrometer was set up, and computer programs were written for neutron diffraction calculations. Excitation functions and n-γ angular correlations for the reaction $^{51}V(p,n)^{51}Cr$ were measured, as were the cross sections for some neutron reactions on Ca isotopes at 14 MeV. Cross sections for the reactions $^{45}Sc(n,2n)^{44m,g}Sc$ were also measured. The decay of ^{147}Nd was investigated; spin-parity assignments were made to levels in ^{147}Pm. Angular distributions from the reaction $^{14}N(n,\alpha)^{11}B$ to low-lying levels of ^{11}B were measured; the distributions were fitted in terms of a heavy-particle stripping mechanism. A decay scheme for ^{76}Ga was proposed on the basis of β-γ and γ-γ coincidence measurements. The $^{174}Yb(n,p)^{174}Tm$ cross section was measured at 14.8 MeV, and the decay of ^{174}Tm was investigated. Equipment for β-γ angular correlation measurements was also developed. Absolute cross sections for (n,2n) reactions on ^{63}Cu, ^{19}F, ^{69}Ga, ^{107}Ag, and ^{64}Zn were measured, as were (n,α) and (n,p) cross sections for 14-MeV neutrons on some Z = 8 to 25 nuclei. Polarization effects in Compton and Rayleigh scattering were also investigated, and the matrix elements for some transitions in ^{111}Ag and ^{160}Tb were studied. Internal bremsstrahlung spectra from ^{210}Bi, ^{51}Cr, ^{31}P, ^{204}Tl, and ^{91}Y were measured, and the decay schemes of ^{99}Mo and ^{97}Zr were investigated. (D.C.W.)

17341 (AERE-M-1709) ETA AND NEUTRON CROSS SECTIONS OF ^{239}Pu AND ^{233}U. Brooks, F. D.; Jolly, J. E.; Schomberg, M. G.; Sowerby, M. G. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 18p. Dep. mn.

Measured values of η for ^{239}Pu and ^{233}U are given for the energy range 0.04 to 11 eV, together with fission and total cross sections for ^{233}U. Average values of η were calculated and also, in the case of ^{233}U, various ratios and integrals of the cross sections and α for energy groups of interest for reactor design studies. Total cross-section measurements were also made for ^{239}Pu from 10 to 1000 eV. Comparisons are included between the results obtained in the experiment and those from other laboratories. (auth)

17342 (ANL-7274) FAST-NEUTRON SCATTERING FROM ELEMENTAL Mo, Sn, Sb, AND Te. Smith, A. B.; Hayes, R. (Argonne National Lab., Ill.). Nov. 1966. Contract W-31-109-eng-38. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Neutrons with incident energies of 0.3 to 1.5 MeV were scattered from elemental Mo, Sn, Sb, and Te. Fast time-of-flight techniques were employed to measure the differential elastic and the differential inelastic scattering cross sections at ≲25-keV increments throughout the incident neutron-energy interval. The inelastic excitation of states was observed: in Mo at 0.20 ± 0.01, 0.50 ± 0.04, 0.79 ± 0.06, and ~1.05 MeV; in Sn at ~1.2 MeV; in Sb at 0.037 ± 0.003, 0.16 ± 0.01, 0.54 ± 0.04, and ~1.1 MeV; and in Te at 0.65 ± 0.02, 0.75 ± 0.02, and 0.85 ± 0.02 MeV. The experimental results were compared with calculations based upon a surface-absorption optical potential and the statistical theory of average compound-nucleus cross sections including corrections for width fluctuations. These comparisons were related to the characteristics of the low-energy excited states of the respective nuclei and to the proton shell closure at Z = 50. (auth)

17343 (DP-MS-66-3) NUCLEAR MOMENT RATIOS IN ^{237}Np FROM MOESSBAUER SPECTRA. Stone, J. A.; Pillinger, W. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 24, 1966. Contract AT(07-2)-1. 13p. (CONF-660633-13). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society, Division of Plasma Physics, Minneapolis, Minn.

The magnetic and quadrupole moments of the ground state and the first excited state of ^{237}Np were investigated by observing Mössbauer spectra of anhydrous $NpCl_4$ and of the intermetallic compound $NpAl_2$ at 4.2 and 77°K. Values of the ratios of the magnetic moments and of the quadrupole moments of the two states were obtained, together with hyperfine structure parameters. (D.C.W.)

17344 (INP-506/PL) LIFETIMES OF EXCITED NUCLEAR STATES IN ^{115}In. Hrynkiewicz, A. Z.; Ogaza, S.; Rybicka, M.; Kulessa, R.; Walus, M. (Institute of Nuclear Physics, Krakow (Poland)). Nov. 1966. 14p. Dep.

The lifetimes of the 597-, 829-, and 864-keV excited states of ^{115}In were measured by means of beta-gamma and gamma-gamma delayed coincidence techniques. The corresponding results are: $T_{\frac{1}{2}}$(597 keV) ≤ 200 psec, $T_{\frac{1}{2}}$(829 keV) = 6.00 ± 0.12 nsec, and $T_{\frac{1}{2}}$(864 keV) = 1.13 ± 0.06 nsec. (auth)

17345 (INR-765/IA/PL) EMISSION OF LONG-RANGE CHARGED PARTICLES IN THE FISSION OF ^{235}U INDUCED BY THERMAL NEUTRONS. Sowinski, M.; Chwaszczewska, J.; Dakowski, M.; Krogulski, T.; Piasecki, E.; Przyborski, W. (Institute of Nuclear Research, Warsaw (Poland)). Oct. 1966. 14p. Dep.

The relative intensities of light particles (protons, deuterons, tritons, and ^{6}He) associated with thermal neutron fission of ^{235}U were measured. Also, events were observed which were attributed to heavier nuclei such as ^{8}He, Li, and Be. (auth)

17346 (JINR-E4-3134) SPIN-QUADRUPOLE FORCES AND COLLECTIVE STATES IN DEFORMED NUCLEI. II. 2^+ STATES. Chernei, M. I.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p. Dep. mn.

Numerical calculations of the energy, E2 transition probability, and one-phonon wave function for the 2^+ collective states in rare-earth deformed nuclei are carried out within the framework of the model with spin-quadrupole interactions. It is shown that the spin-quadrupole interactions affect slightly the energy and E2 transition probability for the lowest 2^+ state. But the spin-quadrupole interactions lead to the significant lowering of the second 2^+ collective state below the two-quasiparticle energy. They affect the decay properties of this state as well. The effect of the spin-quadrupole interactions on the one phonon wave-function structure is also discussed. (auth)

17347 (JINR-P3-3097) NEITRONNYE REZONANSY IZOTOPOV ERBIYA. (Neutron Resonances of Er Isotopes). Karzhavina, E. N.; Popov, A. B.; Yazvitskii, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 34p. (In Russian). Dep. mn.

Neutron-transmission and γ-ray yield measurements were made on samples of natural Er and on samples enriched in the isotopes ^{164}Er, ^{166}Er, ^{167}Er, ^{168}Er, and ^{170}Er. These measurements were made to allow for isotopic identification and for the determination of neutron resonance parameters for ^{164}Er and ^{167}Er in the energy range up to 300 eV, for ^{166}Er up to 1500 eV, and for ^{168}Er and ^{170}Er up to 4000 eV. Other information derived for these isotopes is the average distance between the levels, D; the strength function, S_0; and the radiation width, Γ_γ. An analysis of the data on the strength functions in the range 140 < A < 200 confirms the existence of an additional maximum in S_0 at A ≈ 160. (S.F.L.)

17348 (JINR-P3-3104) IZMERENIE REAKTSII ND (n,α) NA REZONANSNYKH NEITRONAKH. (Measurement of the Reaction Nd (n,α) on Resonance Neutrons). Kvitek, I.; Popov, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 11p. (In Russian). Dep. mn.

The reaction (n,α) was investigated on the natural mixture of the neodymium isotopes at neutron energies up to 400 eV. The occurrence of the reaction (n,α) on the ^{145}Nd isotope is proved by experiment. The values of Γ_α for separate resonances are given. For the ^{143}Nd resonances the values of Γ_α are also obtained and an identification of a number of levels by spins is carried out. The average α-particle widths are compared with the calculations on statistic theory. (auth)

17349 (JINR-P6-3138) IDENTIFIKATSIYA ^{111}Te PO DOCHERNIM PRODUKTAM PROTONNOGO RASPADA. (Identification of ^{111}Te by Daughter Isotopes of Proton Decay). Bogdanov, D. D.; Bacho, I.; Karnaukhov, V. A.; Petrov, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 12p. (In Russian). Dep. mn.

In order to identify a delayed proton emitter ($T_{\frac{1}{2}}$ ~19s), produced by the reaction ^{102}Pd + ^{12}C, the radioactive products of its decay were investigated. To separate these products from the enormous background of γ activity, which is due to other reaction channels, the fact was used that in proton decay the daughter isotopes have a considerable recoil energy. The background is due to the adsorption of the activity on the surface of the cather. This background was practically reduced by means of removing thin layers, 1.5 to 2.0 $\mu g/cm^2$, from the surface of an aluminum cather. In the γ spectrum of recoils the peaks are singled out at the energies 290 ± 27 and 650 ± 28 keV. The half lives of these activities are 3.6 ± 0.6 and 4.0 ± 1.0 hr, respectively. The emission is ascribed to ^{110}Sn and ^{110}In isotopes which are the decay products of ^{111}Te—the delayed proton emitter. (auth)

17350 (KFK-450) THE FISSION CROSS-SECTIONS OF SOME PLUTONIUM ISOTOPES IN THE NEUTRON ENERGY RANGE 5 TO 150 keV. Gilboy, W. B.; Knoll, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 12p. (CONF-661014-43). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

The neutron fission cross sections of ^{239}Pu and ^{240}Pu at 5 to 150 keV were obtained by measuring the ^{239}Pu/^{235}U and ^{240}Pu/^{235}U fission cross-section ratios. (D.C.W.)

17351 (KFK-452) HIGH RESOLUTION CROSS-SECTION MEASUREMENT FOR SOME FAST REACTOR STRUCTURAL MATERIALS IN THE keV ENERGY RANGE. Rohr, G.; Friedland, E.; Nebe, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 14p. (CONF-661014-47). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

Transmission measurements of the neutron total cross sections of Fe, ^{57}Fe, ^{55}Mn, and ^{51}V at 20 to 250 keV were made using the time-of-flight method. A multilevel analysis of the data for ^{55}Mn and ^{51}V yielded resonance parameters for these isotopes, and an area analysis of the data on Fe yielded resonance parameters for ^{56}Fe. (D.C.W.)

17352 (KFK-454) AN ABSOLUTE (n,γ)-CROSS SECTION MEASUREMENT FOR GOLD AT 30 keV AND ITS APPLICATION IN NORMALIZATION OF OTHER DATA. Poenitz, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 28p. (CONF-661014-46). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

The Au(n,γ) cross section was measured at E_n = 30 keV using a Au foil irradiated by a collimated beam of neutrons from the ^{7}Li(p,n)^{7}Be reaction at threshold energy. The purpose of the experiment was to find an absolute cross section value in the keV region useable for the normalization of Au(n,γ) cross section curves. A review is given of the methods used for measurement of neutron capture cross sections in the keV region and of the available data on the (n,γ) cross sections for Au, for which there is considerable disagreement in published values. (S.F.L.)

17353 (KFK-455) CAPTURE CROSS-SECTION MEASUREMENTS FOR SOME MEDIUM AND HEAVY WEIGHT NUCLEI USING A LARGE LIQUID SCINTILLATOR. Kompe, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 12p. (CONF-661014-44). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

Neutron capture cross sections for the nuclei Ag, Au, Cd, Cs, Hf, In, Mo, Nb, Pd, Re, Ta, and W were measured in the energy range from 10 to 150 keV using a pulsed Van de Graaff generator. A large liquid scintillator was used to detect capture events in the samples. All measurements were based on the capture cross section of Au as a standard. (S.F.L.)

17354 (NP-16603) PHOTONUCLEAR DATA INDEX. Baggett, N. V.; Collins, T. M.; Fuller, E. G.; Holland, J. C.; Hubbell, J. H.; O'Connell, J. S. (National Bureau of Standards, Washington, D. C.). Apr. 1, 1966. 96p. GPO $0.55.

An index to experimental data on photonuclear reactions is presented. Organized by element and isotope, each entry in the index supplies quantitative information for a specific reaction on the ranges of excitation energy, source energy, detected particle energy, and emission angles covered in each reference. Information is also given on the type of measurement and the detector used. (auth)

17355 (ZFK-PHA-20) EINIGE LEBENSDAUERMESSUNGEN IM NANOSEKUNDENGEBIET. (Some Lifetime Measurements in the Nanosecond Region). Meiling, Wolfgang; Stary, Franz (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Feb. 1966. 48p. (In German). Dep. mn.

Measurements of nanosecond lifetimes of excited nuclear states were performed, using delayed coincidences. The investigations were related to levels in the spherical nuclei ^{95}Mo, ^{99}Tc, and ^{141}Pr, the deformed odd-mass nuclei ^{153}Eu, ^{161}Dy, ^{175}Lu, and ^{181}Ta, and the deformed even-mass nuclei ^{156}Gd, ^{160}Dy, ^{170}Yb, and ^{182}W. The results are compared with values taken from the literature. (auth)

17356 (ZFK-PHA-23) DIE UNTERSUCHUNG DER EIGENSCHAFTEN DEFORMIERTER KERNE MIT UNGERADER NUKLEONENZAHL IM MASSENBEREICH 150 < A < 190. (Investigation of the Characteristics of Deformed Nuclei With Uneven Nucleon Numbers in the Mass Region 150 < A < 190). Funke, Lothar; Graber, Heinz; Kaun, Karl-Heinz; Sodan, Horst (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Sept. 1966. 253p. (In German). Dep. mn.

Experimental results are presented which were obtained during the study of the decay of deformed nuclei in the mass region 150 < A < 190. In order to discuss these results in connection with modern nuclear models, the important aspects of the unified model as well as the features of the microscopic description of nuclear states are reviewed. The experiments performed are described. Details are given for the preparation of the radioactive sources and for the multiparameter method used in the coincidence measurements. The work includes the investigation of the following nuclear decays: ^{151}Pm(β^-)^{151}Sm, ^{153}Sm(β^-)^{153}Eu, ^{155}Sm(β^-)^{155}Eu, ^{155}Eu(β^-)^{155}Gd, ^{157}Eu(β^-)^{157}Gd, ^{157}Dy(EC)^{157}Tb, ^{159}Gd(β^-)^{159}Tb, ^{161}Gd(β^-)^{161}Tb, ^{161}Tb(β^-)^{161}Dy, ^{163}Tb(β^-)^{163}Dy, ^{163}Er(EC)^{163}Ho, ^{169}Ho(β^-)^{169}Er, ^{175}Hf(EC)^{175}Lu, ^{181}Hf(β^-)^{181}Ta, ^{187}W(β^-)^{187}Re, ^{162}Tb(β^-)^{162}Dy, ^{174}Lu(EC)^{174}Yb. On the basis of these measurements the level schemes of the daughter nuclei were established or improved. A systematic summary is given of the properties of deformed odd-mass nuclei in the region 150 < A < 190. This summary contains the experimental results of this work as well as the experimental results of other authors published up to May 1966. This includes energies of one-quasiparticle states and β-vibrational states, moments of inertia, decoupling parameters, γ branching ratios of E1-transitions, and β transition probabilities. (auth)

17357 E1 TRANSITION PROBABILITIES BETWEEN CORRESPONDING STATES IN ^{155}Tb, ^{157}Tb, AND THEIR NEIGHBOURING ODD-PROTON NUCLEI. Hauser, U.; Knissel, G. (Univ., Heidelberg). Phys. Lett., 24B: 232-4(Mar. 6, 1967).

The half lives of the 227-keV state in ^{155}Tb and of the 326-keV state in ^{157}Tb were determined to be 0.32 ± 0.05 and 0.41 ± 0.09 nsec, respectively. Their transition matrix elements are compared with corresponding $5/2^- \rightarrow 3/2^+$ transitions in their neighboring odd-proton nuclei. (auth)

17358 ALPHA DECAY AND THE STRUCTURE OF β-VIBRATIONAL STATES. Sandulescu, A.; Dumitrescu, O. (Univ. of Helsinki). Phys. Lett., 24B: 212-16(Mar. 6, 1967).

The hindrance factors and the reduced wave amplitudes for alpha transitions to β-states are calculated. It is shown that the alpha intensities are strongly enhanced by the quadrupole forces and that only the superfluid model with pairing and quadrupole-quadrupole residual interactions can explain the experimental data, i.e., β-states are not pure pairing vibrational states. (auth)

17359 ANGULAR DISTRIBUTIONS OF THE ^{90}Zr(d,p) REACTION AND THE COUPLING OF ANALOGOUS (d,p) AND (d,n) CHANNELS. Lynen, U.; Malsburg, Ch. V. D.; Santo, R.; Stock, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 24B: 237-9(Mar. 6, 1967).

The excitation functions and spectroscopic factors of several final levels in the reaction ^{90}Zr(d,p) show an anomaly at the threshold energy for the (d,n) reaction to the ^{91}Zr ground-state analog ^{91}Nb. This indicates a more complicated coupling of the (d,n) and (d,p) analog channels than described by the two-channel approach. (auth)

17360 MEASURING FISSION SPECTRA WITH SEMICONDUCTOR DETECTORS. Gordon, Glen E.; Harvey, John W.; Nakahara, Hiromichi (Massachusetts Inst. of Tech., Cambridge). Nucleonics, 24: 62-6(Dec. 1966).

Detailed investigations were made of the γ-ray spectra of gross fission products at various times following neutron irradiations using high-resolution Ge(Li) detectors. Methods were also developed for determining the ranges in aluminum and the yields of about 20 of these fission products. Typical spectra are given for ^{235}U following thermal-neutron induced fission, and ranges and yields are presented for fission products from ^{233}U. (S.F.L.)

17361 PHOTOFISSION OF Bi, Pb, Au, Pt, Os, Re, Ta, AND Hf BELOW 260 MeV. Ranyuk, Yu. N.; Sorokin, P. V. Yadern. Fiz., 5: 37-41(Jan. 1967). (In Russian).

The fragment angular distributions and photofission cross sections were measured in the energy region 100 to 260 MeV for Bi, Pb, Au, and Pt nuclei, and in the region 200 to 260 MeV for Os, Re, Ta, and Hf nuclei. The angular distributions are isotropic in the whole region of energies and the increase of the photofission cross sections with growing γ-quantum energy is analogous to that in the π-meson photoproduction on hydrogen. (auth)

17362 INVESTIGATION OF THE REACTION $^{238}U + {}^{11}B$ LEADING TO A SPONTANEOUSLY FISSIONABLE ISOMER ^{242}Am. Gangrskii, Yu. P.; Markov, B. N.; Polikanov, S. M.; Yungclaussen, H. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 22-5(Jan. 1967). (In Russian).

The reaction $^{238}U + {}^{11}B$ leading to the ground (1^-), and isomeric (5^-) spontaneously fissionable states of ^{242}Am were investigated. The excitation functions were obtained for the ground and spontaneously fissionable states. For the 5^- state, the averaged cross section was measured in the energy range 50 to 68 MeV. The spin of the spontaneously fissionable isomer was estimated by comparing the cross sections for the production of ^{242}Am in various states. (auth)

17363 NEUTRONS AND γ-QUANTA IN THE SPONTANEOUS TERNARY FISSION OF ^{244}Cm. Adamov, V. M.; Drapchinskii, L. V.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz., 5: 42-8 (Jan. 1967). (In Russian).

The ratios of the average numbers of prompt neutrons and γ-quanta in the spontaneous ternary and binary fission of ^{244}Cm were determined as $\bar{\nu}_{tr}/\bar{\nu} = 0.58 \pm 0.07$ and $\bar{\eta}_{tr}/\bar{\eta} = 0.88 \pm 0.09$. An investigation of the dependence of $\bar{\nu}_{tr}$ and $\bar{\eta}_{tr}$ on the α-particle energy has shown that $\bar{\nu}_{tr}$ decreases from 1.95 to 1.16 whereas $\bar{\eta}_{tr}$ stays constant as the particle energy varies between 15 and 25 MeV. This is an argument in favor of the two stage ternary fission mechanism. Correlated energy distributions of ternary fission γ-quanta and α-particles were obtained. An analysis shows that the γ-quantum energy distributions do not depend significantly on the α-particle energy. The binary and ternary γ-quantum spectra are also identical. It follows that no significant γ-radiation directly connected with the α-particle emission, is emitted in the ternary fission. (auth)

17364 SYNTHESIS OF EINSTEINIUM ISOTOPES IN REACTIONS WITH NITROGEN IONS. Mikheev, V. L.; Ilyushchenko, V. I.; Miller, M. B. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 49-55(Jan. 1967). (In Russian).

The isotopes ^{245}Es, ^{246}Es, and ^{247}Es were produced in the reactions $^{238}U(^{14}N,xn)Es^{252-x}$, using the external beam of the 150-cm cyclotron of the JINR. The relative α-decay and electron capture probabilities for the Es isotopes were determined by detecting the α-decay of ^{245}Es and ^{246}Es and of their electron capture products ^{245}Cf and ^{246}Cf. The properties of the ^{247}Es isotope, on which no data existed previously ($E_\alpha = 7.33 \pm 0.03$ MeV, $T_{\frac{1}{2}} = 5.0 \pm 0.3$ min, $\alpha/E.C. \approx 0.07$), were established. (auth)

17365 NUCLEAR RESONANCE FLUORESCENCE OF ^{152}Sm: NATURE OF THE 963 keV (1^-) LEVEL. Begzhanov, R. B; Islamov, A. A.; Starodubtsev, S. V. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Yadern. Fiz., 5: 250-4(Feb. 1967). (In Russian).

The resonance scattering of γ quanta is used to investigate the 963 keV 1^- level in ^{152}Sm. The use of low temperatures (78°K) enhanced the absorption effect and made it possible to determine with good accuracy the lifetime $\tau = (5.15 \pm 0.50) \times 10^{-14}$ sec of the level by the self-absorption method. An attempt is made to find certain regularities in the behavior of the nuclear matrix elements and reduced widths of E1 transitions in even-even nuclei. (auth)

17366 THE α-DECAY OF ^{240}Cm AND ^{241}Cm. Baranov, S. A.; Aliev, I. G.; Chistyakov, L. V. Yadern. Fiz., 5: 241-9(Feb. 1967). (In Russian).

The α-radiation spectra of ^{241}Cm, ^{240}Cm, and ^{236}Pu were investigated, using a magnetic α-spectrograph with the double focusing of the α-particle beam to the angle $\pi\sqrt{2}$. In the spectra of ^{241}Cm, ^{240}Cm, and ^{236}Pu were found 12, 4, and 2 groups of α-particles, respectively. The energy-level schemes of ^{237}Pu, ^{236}Pu, and ^{232}U were constructed from the experimental data. The existence of rotation bands with the quantum characteristics $\frac{1}{2}^+$ [631] and $\frac{7}{2}^-$ [743] in the level scheme of ^{237}Pu was proved experimentally for the first time in an investigation of the α decay of ^{241}Cm. The half lives of ^{241}Cm and ^{240}Cm were determined. (auth)

17367 DIGITAL ANALYSIS OF PERTURBED ANGULAR CORRELATIONS. Matthias, E.; Shirley, D. A. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 45: 309-12(1966). (UCRL-16779).

When applying perturbed angular correlation methods to isomeric levels with half lives longer than 10^{-6} sec, the limitations of the conventional time-differential technique can be overcome by digital analysis of perturbed angular correlations. This method consists of digitalized recording of the time spectrum and a subsequent Fourier analysis of it. The power of this method is demonstrated by an accurate determination of the g-factor of the 74.8-keV state in ^{100}Rh, which gives $g = +2.160 \pm 0.004$ for a Rh metal source. With a Knight shift correction of +0.43%, the final g-factor is $+2.151 \pm 0.004$. (auth)

17368 ISOTOPES OF ELEMENT 102 WITH MASS 251 TO 258. Ghiorso, Albert; Sikkeland, Torbjorn; Nurmia, Matti J. (Univ. of California, Berkeley). Phys. Rev. Lett., 18: 401-4(Mar. 13, 1967).

Cross sections for the production of No isotopes by (C-12,xn) and (C-13,xn) reactions on Cm isotopes were measured, together with the alpha energies and half lives of the No isotopes. (D.C.W.)

17369 TERNARY FISSION OF HEAVY NUCLEI. Muga, M. L.; Rice, C. R.; Sedlacek, W. A. (Univ. of Florida, Gainesville). Contract AT(40-1)-2843. Phys. Rev. Lett., 18: 404-8 (Mar. 13, 1967). (ORO-2843-9).

The energy and mass distributions of fission fragments from the spontaneous fission of ^{252}Cf and the neutron fission of ^{239}Pu, ^{241}Pu, ^{233}U, and ^{235}U were measured. The data are inconsistent with an explanation in terms of scattering phenomena. (D.C.W.)

17370 MEASUREMENT OF ^{239}Pu RESONANCE FISSION INTEGRAL. Yasuno, Takehiko (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 43-4(Jan. 1967).

The resonance fission integral of ^{239}Pu was measured relative to the resonance capture integral of ^{197}Au using the Cd ratio method. (D.C.W.)

17371 DECAY SCHEME OF ^{99}Mo. Dorikens-Vanpraet, L.; Jacobs, E.; Heyde, K.; Demuynck, J.; Frenne, D. de (Univ., Ghent). J. Phys. (Paris), 28: 1-6(Jan. 1967). (In French).

A careful investigation of the decay of ^{99}Mo by means of gamma and beta spectra and gamma-gamma and beta-gamma coincidence techniques proved the existence of a 1130-keV level and gamma transitions of 410, 620, and 950 keV in ^{99}Tc and of a 240-keV beta transition. The experimental results are compared with the theoretically calculated level scheme. (auth)

17372 NUCLEAR FISSION. Fraser, J. S.; Milton, J. C. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Annu. Rev. Nucl. Sci., 16: 379-444(1966).

A review of the theoretical description and the experimental facts of fission is presented. The transition or saddle-point stage, the saddle-to-scission stage, and the final stage of fission are discussed in order. 164 references. (D.C.W.)

17373 SUBBARRIER FISSION OF ^{232}Th BY NEUTRONS. Ermagambetov, S. B.; Kuznetsov, V. F.; Smirenkin, G. N. Yadern. Fiz., 5: 257-63(Feb. 1967). (In Russian).

The dependence of the reaction cross section on neutron energy was measured in the region 0.6 to 3.0 MeV for the investigation of $^{232}Th(n,f)$ fission near the threshold. Some characteristics of the potential barrier in the fission are discussed, in connection with the results of the experiment. The competition of inelastic neutron scattering to levels of the ^{232}Th target in the energy region 0.75 to 1.0 MeV shows up clearly in the energy dependence of the fission cross section. The disagreement between the known thermal neutron fission cross section 0.06 ± 0.02 mb and the value extrapolated from σ_f at higher energies is discussed. (auth)

17374 FISSION OF TUNGSTEN NUCLEI BY 600-MeV PROTONS. Bychenkov, V. S.; Perfilov, N. A. Yadern. Fiz., 5: 264-70(Feb. 1967). (In Russian).

The cross section for the fission of W by 660-MeV protons is equal to 21 ± 7 mb. The fission products are distributed isotropically in the cms. The mean excitation energy of the fissioning nuclei is equal to 240 ± 50 MeV, and the mean number of charged particles accompanying the fission equals 2.98 ± 0.19. The mass distribution of the fission products was obtained. (auth)

17375 CHANNEL ANALYSIS OF THE NEUTRON FISSION OF ^{230}Th. Vorotnikov, P. E.; Dubrovina, S. M.; Otroshchenko, G. A.; Shigin, V. A. Yadern. Fiz., 5: 295-308(Feb. 1967). (In Russian).

The results are given of fragment angular distribution measurements in the fission of ^{230}Th by 690 to 1230 keV neutrons. An analysis showed that mainly ^{231}Th nuclei in negative-parity states undergo fission. The peak in the fission cross section at $E_n = 750$ keV is totally due to the rotational band with $K^\pi = \frac{1}{2}^-$. The dependence of the fission probability on the excitation energy E^* of the nucleus, can not be explained by the competition from the inelastic scattering of neutrons or by the non-conservation of K, so that it is necessary to assume a nonmonotonous dependence of the fission width Γ_f on E^*. (auth)

17376 INVESTIGATION OF SPONTANEOUSLY FISSILE PRODUCTS IN THE REACTIONS ^{230}Th + ^{10}B AND ^{230}Th + ^{11}B. Kuznetsov, V. I.; Skobelev, N. K.; Flerov, G. N. Yadern. Fiz., 5: 271-3(Feb. 1967). (In Russian).

Spontaneous fission with the half life $T_{1/2}$ = 2.6 ± 0.2 min was detected in the nuclear reactions ^{230}Th + ^{10}B and ^{230}Th + ^{11}B. The excitation functions and production cross sections of this product were studied. Spontaneous fission with a different half-life $T_{1/2}$ = 1.4 ± 0.25 min was observed when ^{230}Th was bombarded by ^{10}B ions with an energy of 82 MeV and higher. A hypothesis is advanced that the 2.6-min decay is due to the spontaneous decay of ^{234}Am in an isomeric state. The experiments were performed on the internal beam of the U-300 cyclotron. (auth)

17377 A STUDY OF ENERGY LEVELS IN ODD-MASS YTTERBIUM ISOTOPES BY MEANS OF (d,p) AND (d,t) REACTIONS. Burke, D. G.; Zeidman, B.; Elbek, B.; Herskind, B.; Olesen, M. (Niels Bohr Inst., Copenhagen). Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 2, 53p(1966).

The (d,p) and (d,t) reactions were studied with 12-MeV deuterons using targets of ^{168}Yb, ^{170}Yb, ^{172}Yb, ^{174}Yb, and ^{176}Yb. The magnetic spectrograph used to analyze the reaction products gave an overall energy resolution of ~0.1%. The observed populations of the low-lying states in the final odd nuclei were in general agreement with predictions based on the stripping theory for deformed nuclei, made by the use of the Nilsson wave functions and single-particle cross sections obtained from a distorted wave Born approximation calculation. The relative populations of the various members of a rotational band based on an intrinsic state are highly characteristic of the state, and change only slightly from one nucleus to another. This property permits the unambiguous assignment of all the low-lying orbitals, except those with very weak cross sections, without the necessity of measuring angular distributions. Many previously unknown levels were found, and ~50 of them were classified in terms of the Nilsson model. In addition, some speculations concerning vibrational states were made. The use of complementary reactions was shown to be of value for determining the hole or particle character of the states. The filling of the orbitals as a function of mass number was in good agreement with pairing theory predictions, and indicated that the pairing energy parameter, Δ, is 0.80 ± 0.15 Mev. (BBB)

17378 DETERMINATION OF NUCLEAR DIPOLE MOMENT OF ^{171}Yb AND ^{173}Yb BY OPTICAL PUMPING. Olschewski, L.; Otten, E.-W. (Univ., Heidelberg). Z. Phys., 200: 224-6(1967). (In German).

The nuclear Zeeman levels of the odd isotopes of ytterbium (^{171}Yb, ^{171}I = 1/2; ^{173}Yb, ^{173}I = 5/2) were polarized in the atomic ground state ($6s^2\ ^1S_0$) by means of optical pumping with the resonance line ($6s^2\ ^1S_0 \longleftrightarrow 6s\ 6p\ ^1P_1$, λ = 3988 Å). The magnetic moments, calculated from the nuclear hyperfine-Zeeman transitions in a magnetic field of 228 G are $^{171}\mu_I = 0.49188(2)\mu_K$ and $^{173}\mu_I = 0.67755(3)\mu_K$, with diamagnetic correction applied. (auth)

17379 THE FAST NEUTRON (n,γ) AND (n,2n) REACTION CROSS SECTIONS ON Re ISOTOPES. Druzhinin, A. A.; Lbov, A. A.; Bilibin, L. P. Yadern. Fiz., 5: 18-21(Jan. 1967). (In Russian).

The (n,γ) and (n,2n) reaction cross sections for Re isotopes were measured using the activation method. The following results were obtained: For neutrons near to the fission neutron spectrum, with $E_{eff} \simeq 0.6$ MeV, $\sigma_{n,2n}(^{187}Re) = 10 \pm 6$ mb, $\sigma_{n,\gamma}(^{187}Re) = 280 \pm 30$ mb, $\sigma_{n,\gamma}(^{185}Re) = 410 \pm 50$ mb. For neutrons with $E_{eff} \simeq 0.8$ MeV, $\sigma_{n,\gamma}(^{187}Re) = 220 \pm 10$ mb, and $\sigma_{n,\gamma}(^{185}Re) = 360 \pm 50$ mb. For 14.8-MeV neutrons, $\sigma_{n,2n}(^{187}Re) = 1490 \pm 160$ mb, $\sigma_{n,2n}(^{185}Re) = 1430 \pm 220$ mb for ^{185}Re(n,2n)^{184}Re, and 260 ± 100 mb for ^{185}Re(n,2n)^{184m}Re. The results obtained are compared with those of other authors. (auth)

17380 ON THE DECAY OF ^{155}Ho. Avotina, M. P.; Grigorev, E. P. (Leningrad State Univ.). Yadern. Fiz., 5: 16-17(Jan. 1967). (In Russian).

A number of the inner conversion-electron spectral lines of ^{155}Ho are measured with the double-focusing β spectrometer. The half life of the ^{155}Ho nucleus ($T_{1/2}$ = 48 ± 2 min) is determined from the decrease in intensity of the conversion lines. Some transitions are established to belong to the ^{155}Ho-decay and not to that of the isotope ^{156}Ho with the near half-life $T_{1/2}$ = 56 ± 2 min. The absolute intensity of the conversion lines is determined by means of comparison with the intensity of the line K227 from the daughter isotope ^{155}Dy. (auth)

17381 SINGLE-PARTICLE STATES BUILT ON THE SECOND 0^+ STATE IN ^{90}Zr. Moore, C. Fred; Zaidi, S. A. A.; Kent, J. J. (Univ. of Texas, Austin). Phys. Rev. Lett., 18: 345-6(Mar. 6, 1967).

Excitation functions for proton elastic and inelastic scattering by ^{90}Zr at 4.5 to 10.0 MeV were measured. The results indicate that certain excited states of ^{91}Zr, the analog of the compound nucleus ^{91}Nb, consist of single-particle excitations of a neutron and a core which is the first excited state of ^{90}Zr. (D.C.W.)

17382 GAMMA-RAYS FROM ^{139}Pr AND ^{143}Sm. Goldman, I. D. (Univ., Sao Paulo, Brazil); Miyao, Y.; Nascimento, I. C.; Da Costa, N. L.; De Pinho, A. G. Nuovo Cimento (10), 47B: 306-9(Feb. 11, 1967).

Gamma spectra from the decay of ^{139}Pr and ^{143}Sm were measured. Some previously unreported levels in ^{139}Ce and ^{143}Pm were observed; spin-parity assignments were made for several energy levels of these nuclei. Log ft values for a number of transitions were determined. (D.C.W.)

17383 THE SPIN–SPIN INTERACTION OF 0.92-MeV POLARIZED NEUTRONS WITH POLARIZED ^{165}Ho NUCLEI. Kobayashi, Shinsaku; Kamitsubo, Hiromichi; Katori, Kenji; Uchida, Akira; Imaizumi, Minoru; Nagamine, Kanetada (Tokyo Univ.). J. Phys. Soc. Jap., 22: 368-78(Feb. 1967).

In order to a direct measure of the strength and form of the nuclear spin-spin interaction, the transmission of 0.92-MeV polarized neutrons by polarized ^{165}Ho was measured. The total cross section and relative scattering angular distribution of 0.92-MeV unpolarized neutrons through unpolarized ^{165}Ho nuclei were also measured in order to make a parameter search of the optical potential. The experimental results are analyzed with Davies and Satchler's DWBA formalism. The results show that the effective spin-spin interaction between a free neutron and a ^{165}Ho nucleus is an attraction type and its strength has the order of one MeV. The present experimental results together with other data obtained at ORNL and Stanford can be fitted by the DWBA approach in either case of a volume and surface type of the form factor. For the further determination of the strength and the form of the spin-spin interaction, more precise similar experiments are needed for various different neutron energies. (auth)

17384 INVESTIGATIONS OF THE NUCLEAR MATRIX ELEMENTS (nme) OF THE OUTER GROUP OF THE β TRANSITION ($W_0 = 5.26\ m_0c^2$) IN ^{140}La–^{140}Ce. Subotowicz, M. (Curie-Sklodowska Univ., Lublin). Acta Phys. Pol., 30: 943-61(Dec. 1966).

The β–γ directional correlation factor A_2 of the ^{140}La–^{140}Ce β–γ cascade for the outer group of β electrons (W_0 = 5.26) and the following γ transition (E_γ = 1.60 MeV) was measured as a function of the electron energy W. Using the χ^2-test method, the set of Kotani parameters Y, x, u, z and of nme was found for this β transition with best fit of the following currently known observables: A_2^x — reduced β–γ directional correlation factor; C(W) shape factor; ω — β–γ circular polarization directional correlation factor; and ft-value. All the currently known sets of nme for the outer group of this β transition of ^{140}La are critically analyzed with regard to the application of different nuclear models. The set of nme obtained is in satisfactory agreement with the conserved vector current theory. It has been shown that the measurement of the energy dependence of the ω-factor can be a sensitive experimental method to choose the most reliable set of nme. (auth)

17385 STUDY OF NUCLEAR ENERGY LEVELS IN ^{121}Sb, ^{123}Sb, ^{125}Sb, AND ^{127}I USING β- AND γ-RAY SPECTROSCOPY. Auble, Ronald Lavern. Lansing, Mich., Michigan State Univ., 1966. 116p.

Thesis.

The decay schemes of several odd-A tellurium (A = 121, 127) and tin (A = 123, 125) isotopes were examined in an effort to gain information about the nuclear level structure of adjacent antimony and iodine isotopes. Beta and gamma singles and coincidence spectroscopy were used to determine the ordering of the gamma transitions, and therefore, the energies of the nuclear levels. Several levels which had been previously unobserved were located in each of the four isotopes. Angular-correlation measurements on the prominent gamma-gamma cascades in ^{121}Sb, ^{125}Sb, and ^{127}I were made to study the spins of the nuclear states and the mixing ratios of the gamma transitions. The spectrum shape of the beta rays feeding one of the excited states in ^{123}Sb was studied and was found to yield an essentially linear Fermi–Kurie plot. This result, in conjunction with the corresponding log ft value, suggests a non-unique, first-forbidden assignment for this beta transition and limits the possible spin assignments for the ^{123}Sb state. Comparisons are made of the existing experimental data with the predictions of several nuclear models. In the low-energy regions of ^{121}Sb and ^{127}I, sufficient data on mixing ratios and lifetimes are available to make quantitative comparisons with predictions of the single-particle model and with the pairing-plus-quadrupole residual interaction calculations of Kisslinger and Sorensen. Partial agreement is found between the experimental data and the latter predictions. At higher excitations, only qualitative comparisons can be made due to the lack of gamma lifetime and mixing ratio

measurements. A model which is found to predict level structure similar to that observed experimentally is one in which the low-lying particle states are coupled to excitations of the nuclear core. However, several high-energy states in ^{125}Sb are found to deviate from the predictions of this model. Thus, other types of excitation must also be assumed to exist. The nature of these states can only be determined after additional experimental data become available. (Dissertation Abstr.)

17386 INTERMEDIATE STRUCTURE INVESTIGATIONS IN THE LEAD REGION BY MEANS OF POLARIZED ELASTIC FAST-NEUTRON SCATTERING. Aspelund, O. (Aktiebolaget Atomenergi, Studsvik, Sweden). 9p. (CONF-660906-42). DTIE.

From International Conference on Nuclear Physics, Gatlinburg, Tenn.

Partial results of comprehensive investigations into the possible existence of an intermediate structure in the energy dependence of the fast-neutron interaction with complex nuclei in the lead region are presented. Positive evidence for such an effect is found in natural Tl and Bi, although not so conclusive as previously reported in natural Pb. Natural Hg is so far inconclusive. (auth)

Nuclear Theory

Refer also to abstracts 17135, 17136, 17185, 17268, 17298, 17309, 17318, 17321, 17322, 17358, and 17383.

17387 (ISS-66/40) SEPARATION ENERGIES, SINGLE PARTICLE ENERGIES, AND THE (p,2p) AND (e,e'p) REACTIONS. Amaldi, U. Jr. (Istituto Superiore de Sanita, Rome (Italy). Laboratori di Fisica). Nov. 5, 1966. 35p. Dep. mn.

The conditions that (p,2p) and (e,e'p) reactions have to satisfy to be considered quasi-free scattering reactions and the modifications and corrections that have to be applied to a first simple picture of the process are briefly discussed. The (p,2p) and (e,e'p) measurements of separation energies of 1s and 1p protons are presented. These data are compared with the published results of self-consistent Hartree–Fock and Brueckner calculations of single particle energies in ^{16}O and ^{40}Ca, clarifying the connection between these energies and the measured separation energies. Finally, there is a short comment on the still unsolved experimental and theoretical problems and future developments. (auth)

17388 (JINR-P4-3153) K VOPROSU OB ASIMMETRII NEITRONOV PRI μ-ZAKHVATE NA YADRAKH. (To the Problem of Neutron Asymmetry at μ-Capture on Nuclei). Belyaev, V. B.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep. mn.

The asymmetry of the neutron emergence from the polarized μ-meson capture is investigated on the basis of the two-particle effective Hamiltonian. The maximum value of the asymmetry (+1) is obtained neglecting the momentum of a recoil nucleus. (auth)

17389 (JINR-P4-3154) O SKHODIMOSTI 2-CHASTICHNYKH RAZLOZHENII V ZADACHE TREKH TEL. (Investigation of Two-Particle Disintegration in Three-Body Problem). Akhmadkhadzhaev, B.; Belyaev, V. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep. mn.

The convergence of two-particle disintegrations is investigated by the example of a precise solution of the three-body problem. (auth)

17390 (UCRL-Trans-949(Rev.)) NUCLEAR REACTIONS INDUCED BY HIGH ENERGY PARTICLES. Perfilov, N. A.; Lozhkin, O. V.; Ostroumov, V. I. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley), from Yadernye Reaktsii Pod Deistviem Chastits Vysokikh Energii. 453p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $23.50 fs, $10.13 mf.

A review is given of the process of inelastic interactions of high-energy particles (approximately from 50 MeV, where the Bohr formalism of the compound nucleus stops being valid, up to 10^4 MeV) with nuclei. The fundamental experimental results that were obtained during the study of nuclear reactions, as well as a comprehensive review of the theoretical representations concerning the nuclear interactions, are presented. (68 references). (S.F.L.)

17391 INDICATIONS FOR ISOSPIN DEPENDENCE OF ANGULAR DISTRIBUTIONS IN NUCLEON TRANSFER REACTIONS. Fuchs, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Santo, R. Phys. Lett., 24B: 234-7(Mar. 6, 1967).

Angular distributions of $l = 1$ transitions in the reactions ^{11}B(d,t)^{10}B, ^{9}Be(d,n)^{10}B, and ^{13}C(d,n)^{14}N exhibit a dependence on the isospin of the residual state. Possible connections with the $(U_1/A) \cdot (T \cdot t)$ term in the nucleon-nucleus potentials are discussed. (auth)

17392 ELASTIC SCATTERING OF VERY HIGH ENERGY PARTICLES FROM NUCLEI. Czyz, W.; Lesniak, L. (Inst. of Nuclear Physics, Krakow). Phys. Lett., 24B: 227-9(Mar. 6, 1967).

The results are presented of calculations of the elastic scattering cross sections of nucleons scattered from nuclei. Numerical results are presented for ^{4}He target nucleus and are compared with the recent experimental data. (auth)

17393 $1f^1/_2 - 2p^3/_2$ INTERACTIONS. Schwartz, J. J. (Univ. of Rochester, N. Y.). Phys. Lett., 24B: 224-6(Mar. 6, 1967).

The strength of the interactions between nucleons in the $1f^1/_2$ shell and $2p^3/_2$ shell was studied for nuclei with A = 40 to 60. Particle states produced by stripping with (^{3}He,d) and (d,p) reactions, as well as hole states produced by pickup with (p,d) reactions, are considered. It is found that the strength of the $1f^1/_2 - 2p^3/_2$ interaction remains essentially constant throughout nuclei ranging from calcium to nickel. The positions of the centroids of the $p^3/_2$ states in ^{49}V, ^{50}V, ^{51}Cr, and ^{51}Mn are predicted. (auth)

17394 PARTICLE-HOLE EXCITATIONS IN ^{12}C AND ^{40}Ca PHOTOREACTIONS. Marangoni, M.; Saruis, A. M. (CNEN, Bologna). Phys. Lett., 24B: 218-21(Mar. 6, 1967).

The ^{12}C and ^{40}Ca photonuclear cross sections were calculated using an extended particle-hole model to continuum basic configurations. Only 1-particle, 1-hole configurations are considered. A zero-range force was assumed for the particle-hole interaction. The theoretical results are compared with experimental data. (auth)

17395 RELATION BETWEEN PROTON–NUCLEUS AND PROTON–NUCLEON INTERACTION AT 20 GeV. Frahn, W. E. (International Center for Theoretical Physics, Trieste, Italy). Phys. Lett., 24B: 216-18(Mar. 6, 1967).

It is shown that the parameters for proton-nucleus scattering at 19.3 GeV/c are closely related to those for proton-nucleon scattering at the same energy. (auth)

17396 APPLICATION OF NOMOGRAMS FROM FLATTENED POINTS IN NUCLEAR REACTIONS KINEMATIC. Potetyunko, G. N. At. Energ. (USSR), 21: 254-62(Oct. 1966). (In Russian).

Kinematic ratios of nuclear reactions at relativistic energies are described by nomogram with aligned points. Nomograms are given for resolving kinematic problems in reactions yielding two particles and other problems (conversion of cross sections and solid spectra from laboratory system coordinates into the center of mass system) for reactions yielding three or more particles. The nomograms developed mechanized a considerable part of the calculations and permitted one to follow the peculiarities of the physical pictures of scattering which are derived from kinematic ratios. The effects of errors in measurements on the calculations of other kinematic parameters are evaluated. (R.V.J.)

17397 REGGE POLES AND POLARIZATION EFFECTS IN RESONANCE NUCLEAR REACTIONS. Grushin, V. V.; Nikitin, Yu. P. (Moscow Inst. of Engineering Physics). Yadern. Fiz., 5: 173-85(Jan. 1967). (In Russian).

Resonance nuclear reactions at low energies, involving particles with spins 0 and $^1/_2$ are considered by the Khuri method, using the concept of moving Regge poles. Formulae are obtained for the angular distributions and polarizations of the products of the two-particle resonance reaction $a + A \rightarrow b + B$, differing from the Breit–Wigner ones, because of the complex character of the resonance level angular momentum. The experimental data on the resonance scattering of α-particles and protons on the ^{12}C nucleus are analyzed. The characteristics are obtained of Regge pole trajectories, causing the resonance scattering in states with the quantum numbers 1^+ and $^1/_2$. The possibility of observing effects due to the complexness of the angular momentum in resonance reactions involving mesons and baryons is discussed. (auth)

17398 PERTURBATION THEORY FOR THE DEGENERATE LEVELS OF A SYSTEM OF PARTICLES. Vagradov, G. M. Yadern. Fiz., 5: 67-76(Jan. 1967). (In Russian).

The determination of the total Hamiltonian eigenfunctions and eigenvalues is considered for a system, where the level studied is degenerate when the perturbation is switched off. It is shown that field theory and in particular the graphical representation of the perturbation series can be applied in this case. The application of Green functions to problems with degenerate levels is discussed. (auth)

17399 NUCLEAR MAGNETIC MOMENTA IN EXCITED STATES. Osadchiev, V. M.; Troitskii, M. A. Yadern. Fiz., 5: 85-7(Jan. 1967). (In Russian).

The magnetic momenta of nuclei in excited states are calculated using the solution of the equation for the nuclear magnetic susceptibility. The results are compared with experiments. (auth)

17400 BINDING ENERGY AND WAVE FUNCTIONS OF ^{3}H AND ^{3}He. Simonov, Yu. A.; Badalyan, A. M. Yadern. Fiz., 5: 88-100(Jan. 1967). (In Russian).

The method of six-dimensional angular harmonics is applied to ^{3}H and ^{3}He. Equations taking the spin and isospin into account, but neglecting the tensor forces, are written for the partial waves $\chi_K^\nu(\rho)$. It is shown, that the ^{3}H and ^{3}He wave functions are determined with good accuracy by the single term $\chi_0^0(\rho)$ for general two-particle potentials without an infinite repulsive core. The nuclear form factors are expressed in terms of the partial waves $\chi_K^\nu(\rho)$. It is shown that a difference between the charge form factors of ^{3}H and ^{3}He can only be due to Coulomb effects. The binding energy, Coulomb correction, and ^{3}H form factors are calculated in the first approximation, for a square-well two-body potential, with parameters taken from the two nucleon problem. They agree with the experimental data within 5 to 10%. (auth)

17401 THREE-PARTICLE NUCLEAR REACTIONS AND THE COMPLETE EXPERIMENT. Lazarev, L. M. Yadern. Fiz., 5: 101-8(Jan. 1967). (In Russian).

The "complete experiment" is considered for nuclear reactions with open two- and three-particle channels. It is shown that the matrix elements of the processes a + A → 1 + Y and 1 + Y → 1 + Y' (Y, Y' are unstable particles) can be constructed from the complete experiment. The part of the reaction matrix, corresponding to the elastic scattering a + A and the reaction a + A → 1 + Y → 1 + 2 + 3, near to the production threshold of Y, can be constructed without performing three-particle scattering experiments. (auth)

17402 THE (p,n)-REACTION ON ^{208}Pb. Vashakidze, I. Sh. (Tbilisi State Pedagogical Inst., Georgian SSR). Yadern. Fiz., 5: 109-14(Jan. 1967). (In Russian).

The experimentally observed features of the (p,n) reaction on ^{208}Pb are explained on the basis of the proton-neutron hole interaction mechanism. (auth)

17403 VIRTUALITY EFFECTS IN QUASIELASTIC SCATTERING. Blokhintsev, L. D.; Dolinskii, E. I. (Moscow State Univ.). Yadern. Fiz., 5: 115-22(Jan. 1967). (In Russian).

Effects due to the virtuality of the intermediate particles in quasielastic scattering reactions are studied using the graph theory of direct nuclear reactions. It is demonstrated on the example of the (N,N'd) reaction, that the neglecting of such effects leads to large errors. It is noted that the considered effects are not taken into account in the usual calculations of direct reaction amplitudes, using the wave-function formalism. (auth)

17404 DIFFRACTION EFFECT IN THE ANGULAR DISTRIBUTION OF TRANSFER REACTION PRODUCTS. Gareev, F. A.; Grabovskii, Ya.; Kalinkin, B. N. (Joint Inst. of Nuclear Research, Dubna, USSR). Yadern. Fiz., 5: 123-8(Jan. 1967). (In Russian).

The diffraction effect in the anguiar distribution of the transfer reaction products is treated. Its relation to the parameters characterizing collisions between nuclei is established. It is qualitatively explained why an asymmetry exists in the half-widths of the stripping and pick-up reaction product energy spectrum. (auth)

17405 A METHOD TO DETERMINE THE d-NEUTRON STRENGTH FUNCTIONS FOR EVEN-EVEN NUCLEI FROM RADIATIVE CAPTURE CROSS-SECTIONS. Kononov, V. N. Yadern. Fiz., 5: 129-33(Jan. 1967). (In Russian).

In cross sections of the neutron radiative capture by even-even nuclei a drop due to the competition of the inelastic scattering has been observed. It is shown that by measuring the magnitude of this decrease one can obtain the partial cross sections of the orbital momentum l = 2 neutron capture and the corresponding neutron strength functions. One can apply this method to the determination of d-neutron strength functions for about 50 nuclei mainly in the domain of deformed nuclei. (auth)

17406 FIELD-THEORETICAL METHOD IN THE MANY BODY PROBLEM. III. APPLICATIONS. ATOMKI (At. Kut. Intez.) Kozlem., 8: 266-76(Sept. 1966). (In Hungarian).

Some of the applications of the Brueckner approximation are examined, considering it to be an extension of the Schroedinger perturbation calculation. The Brueckner approximation yields similar results but instead of the two-particle interaction; a special matrix is used in the matrix element related to the interaction. The case considered is similar to the application of the electrostatic Coulomb law but applying to the center of a dielectric material instead of vacuum. The system of equations obtained may be solved by iteration. The energy of the various quantum levels of the Fermi system under study for an interaction-free case must be known, and the interaction must also be given. In view of the averaging of the heavy nuclei, the spin dependence is not taken into account in the formulas derived for the potentials. The values obtained by Brueckner's approximation agree with experimental data. As examples, the interaction of 2 helium atoms in liquid ^{3}He and of 2 neutrons in neutron matter are closely examined. (TTT)

17407 SOME RESULTS CONCERNING A NONLOCAL MEAN FIELD. Monsonego, G.; Piepenbring, R.; Richert, J. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 28: 21-5(Jan. 1967). (In French).

A nonlocal mean field with diffuse edge was studied. The individual states and wave functions in the case of light spherical and deformed nuclei were obtained by numerical solution. (auth)

17408 DETERMINATION OF THE MOMENTUM OF PROTONS IN NUCLEI BY THE KINEMATIC STUDY OF QUASI-ELASTIC PARTICLE-BOUND PROTON COLLISIONS. Bastard, Claude (Univ., Lyon). J. Phys. (Paris), 28: 7-10(Jan. 1967). (In French).

The kinematics of high energy "particle-nucleus" scattering with emission of a proton was studied to determine the momentum distribution of protons in nuclei. The results are applied to the scattering of 1-GeV/c π^- by the nuclei in a freon bubble chamber. (auth)

17409 CP-PARITY NONCONSERVATION AND TRIPLE CORRELATIONS. Lobov, G. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 5: 446-52(Feb. 1967). (In Russian).

$\beta\gamma\gamma$-correlations were calculated for the general case of mixed γ transitions with any multipolarity and allowed nuclear β transitions. A simple expression for $\beta\gamma$ correlations is obtained for allowed β transitions in polarized nuclei in the specific case, when the γ transition is a mixture of M1 and E2 radiations. The finite dimensions of the nucleus and the final-state interaction of the β-electron with the Coulomb field of the nucleus are taken into account in $\beta\gamma\gamma$- and $\beta\gamma$-correlation calculations. The experimental data and predictions of various models on the degree of CP-parity violation in processes involving strongly interacting particles are discussed. (auth)

17410 NUCLEAR MOMENTA AND TRANSITION PROBABILITIES FOR LOW-LYING STATES IN SPHERICAL NUCLEI. Khodel, V. A. Yadern. Fiz., 5: 56-66(Jan. 1967). (In Russian).

A method of describing the low-lying states of spherical nuclei with an open subshell is considered using the model of an isolated single particle level ν_0. It is shown that an important role in the problem is played by excited states of the system with near excitation energies, produced when the quasi-particle filling of the ν_0 shell is reshuffled. An equation is obtained for the transition amplitude, generalizing the Dyson equation to the case of spherical systems. A method is suggested for calculating the single-particle characteristics of low lying excited states in spherical nuclei in the framework of the finite Fermi system theory. (auth)

17411 MODES OF RADIOACTIVE DECAY INVOLVING PROTON EMISSION. Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Annu. Rev. Nucl. Sci., 16: 1-30(1966).

A review of experimental and theoretical observations on proton emission in nuclear decay is presented. The emission of delayed protons, proton radioactivity, and two-proton radioactivity are discussed. 71 references. (D.C.W.)

17412 CHEMICAL AND STRUCTURAL EFFECTS ON NUCLEAR RADIATIONS. DeBenedetti, Sergio; Barros, Fernando DeS.; Hoy, Gilbert R. (Carnegie Inst. of Tech., Pittsburgh). Annu. Rev. Nucl. Sci., 16: 31-88(1966).

A review of chemical and structural effects on nuclear processes is presented. Chemical effects on transition rates, environmental effects on Moessbauer spectra, and environmental effects on γ-γ angular correlations are discussed. 170 references. (D.C.W.)

17413 THERMAL EQUILIBRIUM NUCLEAR ORIENTATION. Shirley, David A. (Univ. of California, Berkeley). Annu. Rev. Nucl. Sci., 16: 89-118(1966). (UCRL-16764).

A review is presented describing the technical advances in the area of low-temperature nuclear orientation for systems of nuclei in thermal equilibrium with the lattice in which they are embedded. Some applications of nuclear orientation in nuclear and solid-state physics are discussed including experimental results. 216 references. (D.C.W.)

17414 ISOBARIC SPIN IN NUCLEAR PHYSICS. Robson, D. (Florida State Univ., Tallahassee). Annu. Rev. Nucl. Sci., 16: 119-52(1966).

A review of the isospin formalism is presented. Selection rules for nuclear decay and reactions are discussed. 86 references. (D.C.W.)

17415 FLUCTUATIONS IN NUCLEAR REACTIONS. Ericson, T. (CERN, Geneva); Mayer-Kuckuk, T. Annu. Rev. Nucl. Sci., 16: 183-206(1966).

A review of the basic concepts of nuclear cross-section fluctuations is presented. The statistical properties of amplitudes and cross sections are discussed together with damping phenomena. 103 references. (D.C.W.)

17416 PARTICLE–PARTICLE-TYPE EXCITATION SPECTRA IN ^{210}Bi AND ^{206}Tl. Birbrair, B. L.; Bukat, G. M.; Guman, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 5: 274-6(Feb. 1967). (In Russian).

The ^{210}Bi and ^{206}Tl excitation spectra are calculated using the theory of finite Fermi systems. (auth)

17417 INTERNAL CONVERSION COEFFICIENTS FOR HIGHER SHELLS IN ATOMS. Borisoglebskii, L. A. (Belorussian State Univ., Minsk). Yadern. Fiz., 5: 379-83(Feb. 1967). (In Russian).

The numerical values of internal conversion coefficients are given for the M_{IV}, M_V, N_I, N_{II}, and O_I atomic subshells in nuclear M1, M2, E1, and E2 transitions. They were obtained by numerically integrating a system of differential Dirac equations, taking the finite dimensions of the nucleus and the screening, according to Thomas–Fermi–Dirac (Z = 81) or Hartree (Z = 80), into account. (auth)

17418 CALCULATION OF DOPPLER-BROADENED CROSS SECTIONS DIRECTLY FROM DOPPLER- (AND RESOLUTION-) BROADENED CROSS SECTIONS CORRESPONDING TO A LOWER TEMPERATURE. Froehner, F. H. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Instrum. Methods, 49: 89-92(Mar. 1967). (GA–7429(and Add.)).

Conventionally, a Doppler-broadened cross section for a given temperature T is calculated from the zero-temperature cross section by means of a convolution. A simple proof is presented for the fact that instead of starting from the zero-temperature cross section one can as well start from the Doppler-broadened cross section for a finite temperature $T' < T$, and use essentially the same convolution. The proof is given for the exact free-gas kernel and also for the commonly used approximation to a broadened Breit-Wigner resonance. Some implications are discussed briefly. (auth)

17419 INFLUENCE OF THE NUCLEAR MAGNETIC MOMENT ON THE BREMSSTRAHLUNG OF LONGITUDINALLY POLARIZED ELECTRONS. Kerimov, B. K.; Abutalybov, I. M. (Azerbaidzhan State Univ., USSR). Yadern. Fiz., 5: 153-63 (Jan. 1967). (In Russian).

The bremsstrahlung cross-section is calculated in the Born approximation for the scattering of longitudinally polarized electrons on oriented and non-oriented nuclei. A formula is obtained describing the influence of the nuclear magnetic dipole moment on the angular distribution of the bremsstrahlung circular polarization degree. A comparison is made with the results for target nuclei with zero magnetic moment. It is shown that nuclear magnetic moment effects show up significantly for large emission angles ($\theta \to 180°$) of circularly polarized bremsstrahlung photons. (auth)

17420 ANGULAR DISTRIBUTION OF INTERNAL CONVERSION ELECTRONS FROM STRONGLY FORBIDDEN γ TRANSITIONS. Borisoglebskii, L. A. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 9-16(May-June 1966). (In Russian).

The anisotropy and angular distribution of conversion electrons during M1 and E1 transitions of oriented nuclei in relation to the magnitudes of nuclear parameters were studied taking into account the influence of the surface layer and nuclear deformation on electron functions. (tr-auth)

17421 FOUNDATION OF THE SURFACE DELTA-INTERACTION. Faessler, A. (Univ., Freiburg i. B.); Plastino, A. Nuovo Cimento (10), 47B: 297-300(Feb. 11, 1967).

The surface delta interaction was investigated using the s-wave phase shift of N–N scattering in vacuum. An attempt was made to simulate the realistic N–N interaction by using a simple, separable force. Only nucleons in the vicinity of the Fermi surface were considered. (D.C.W.)

17422 NEUTRON–NUCLEUS INTERACTION. Cassola, R. L.; Koshel, R. D. (Ohio Univ., Athens). Nuovo Cimento (10), 47B: 303-5(Feb. 11, 1967).

A systematic analysis of 34 neutron elastic-scattering angular distributions was made for incident neutron energies of 6, 7, 14, and 24 MeV in order to test the validity of the optical model and to study the energy dependence of the potential parameters. (D.C.W.)

17423 RESONANCE SCATTERING OF γ RAYS. Barit, I. Ya.; Podgoretskii, M. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 4: 1257-8(Dec. 1966). (In Russian).

The shift of the absorption and emission lines presents experimental difficulties in the study of resonance scattering and absorption of γ rays by nuclei. To overcome this, a new method, based on the determination of frequency changes due to the Doppler effect, was developed. The method requires a moving source; in view of the limitations resulting from the available ultracentrifuges, it is suitable only for studying 6 radiations with energies up to about 1 MeV. Another widely used method is based on the determination of resonance scattering in a continuous bremsstrahlung spectrum; it involves the comparison of the absorption by two neighboring elements. Combination of these two methods opens up new experimental possibilities: the requirement to use nonresonance absorption may be eliminated and the necessary speed of the source may be reduced by an order of magnitude, regardless of the γ quantum energy. The proposed method which may be applied also to the compensation of the energy shift due to recoil caused by an earlier decay process, is similar to the one used in neutron spectroscopy. (TTT)

17424 POLARIZED NUCLEONS. Barschall, H. H. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Amer. J. Phys., 35: 119-24(Feb. 1967). (COO–7-0397).

An elementary description of polarization phenomena involving spin-½ particles is given. With the aid of schematic diagrams, the relation between analyzing power and polarization is obtained. Single and double scattering by spin-0 nuclei and depolarization effects in the scattering by nuclei with spin are discussed. A brief treatment of polarization phenomena in reactions is presented. (auth)

17425 DIFFERENCE BETWEEN LOG FT VALUES OF NEGATRON DECAYS AND POSITRON DECAYS FROM ODD–ODD NUCLEI TO EVEN–EVEN NUCLEI. Ejiri, Hiroyasu (Tokyo Univ.). J. Phys. Soc. Jap., 22: 360-7(Feb. 1967).

Comparison of negatron decays with positron decays is made for allowed GT-type transitions from the ground 1+ states in odd-odd nuclei to the ground 0+ and first 2+ states in even-even nuclei. The ft values of negatron decays are systematically larger than those of positron decays by factors $2 \sim 12$. The difference between log ft values of negatron decays and positron decays is discussed in terms of the theoretical effective coupling constant g_{eff} and the pairing model. (auth)

17426 SURFACE-ENERGY TENSORS. Rosenkilde, Carl E. (Univ. of Chicago). J. Math. Phys. (N. Y.), 8: 84-8(Jan. 1967).

The surface-energy tensors are defined, and general expressions for their first variations are obtained. These quantities are appropriate for an investigation of the equilibrium and the stability of a charged liquid drop (held together by a constant surface tension) using the method of the tensor virial, which was developed by Chandrasekhar and Lebovitz for the theory of self-gravitating masses. The definitions are shown to be consistent with the conservation laws. (auth)

17427 SURFACE-ENERGY TENSORS FOR ELLIPSOIDS. Rosenkilde, Carl E. (Univ. of Chicago). J. Math. Phys. (N. Y.), 8: 88-97(Jan. 1967).

The surface-energy tensors are evaluated for ellipsoidal surfaces in terms of particular types of elliptic integrals which have simple algebraic recursion relations that are useful for numerical evaluation. The final expressions are given in a form appropriate for an investigation of stability using the method of the tensor virial. (auth)

17428 STABILITY OF AXISYMMETRIC FIGURES OF EQUILIBRIUM OF A ROTATING CHARGED LIQUID DROP. Rosenkilde, Carl E. (Univ. of Chicago). J. Math. Phys. (N. Y.), 8: 98-118(Jan. 1967).

The method of the tensor virial is used to investigate the equilibrium and stability of a rotating, uniformly charged (with a total charge Q), incompressible liquid drop (of volume V) held together by a constant surface tension T. The tensor virial theorems provide relations which define the sequences of equilibrium figures and perturbation equations which govern the oscillations. Since spheroids satisfy the virial theorems of orders one, two, and three, the stability of exact axisymmetric equilibrium figures with respect to second- and third-harmonic deformations can be inferred from the nature of the characteristic oscillation frequencies of spheroids. As the rotation increases for a given fissionability parameter $x = Q^2/10TV$ ($0 \leq x < 1$), a sequence of oblate spheroids representing initially stable rotating ground states exhibits a neutral point (where an ellipsoidal sequence bifurcates), but remains stable (in the absence of dissipation) until one of the three second-harmonic modes of vibration (the toroidal or γ mode) becomes overstable. Later, for third harmonics, it exhibits a second neutral point (where a sequence of asymmetric figures bifurcates), but again remains stable until the onset of the associated overstability. A third neutral point does not indicate the bifurcation

of pear shapes. The error in using oblate spheroids is less than 5% up to the first overstable point. One class of saddle shapes can be represented by prolate spheroids (which must rotate about the symmetry axis) in the neighborhood of x = 1. They are initially unstable with respect to the other two second-harmonic modes of vibration (the pulsation or β mode and the transverse-shear mode). (auth)

17429 INTRODUCTORY NUCLEAR THEORY. Second Edition. Elton, L. R. B. London, Sir Isaac Pitman and Sons Ltd., 1965. 341p. 45s.

A survey of nuclear theory is presented covering nuclear forces, decay, models, reactions, and structure. A treatment of the scattering of polarized beams is included, as is a more thorough treatment of parity violation and the coupling constants in beta decay. (D.C.W.)

17430 STRONG DYNAMICAL CORRELATIONS IN EXTENDED NUCLEAR SYSTEMS. Wang, Tso-pin. St. Louis, Washington Univ., 1966. 183p.

Thesis.

A generalization of the usual concept of nuclear matter is introduced, and an application to Bose and Fermi examples of such systems is presented. The properties of the ground state of a uniform extended system of structureless α particles is studied by means of the method developed by Wu and Feenberg. The method of correlated basis functions (CBF), developed by Clark and Westhaus, is used to calculate the energy moments $\sigma_n = \int\sigma(w)w^n dw$, n = −1, 0, 1, of the photonuclear cross section of nuclear matter and the behavior of the ground-state energy of the neutron gas as a function of density. The Wu-Feenberg method requires the use of a Bijl-Dingle-Jastrow wave function and the Kirkwood superposition approximation. The assumed α-α interactions fit the S-wave phase shifts up to a cms energy of 10 MeV. The results, in comparison with results from theoretical nuclear-matter calculations which entertain no clustering, are of value in making crude estimates of the percentage of the surface matter of a heavy nucleus which prefers to form into α clusters and in interpreting empirical values for the compressibility of nuclear matter. The prediction is in concurrence with a recent interpretation of high-energy (p-α) data, that ~5–8 long-lived α substructures reside in a heavy nucleus like that of gold. Applying the CBF method, the dipole sum rules of Levinger and Bethe are used to estimate the influence of strong dynamical correlations, generated by realistic 2-nucleon potentials, on the photoeffect in heavy nuclei. The required nuclear ground-state wave function is taken, in each σ_0 calculation, as a linear combination of correlated basis functions $F\Phi_m$, where F is a product of 2-body correlation factors f appropriate to a system with strong short-range repulsions and $\{\Phi_m\}$ a complete set of Fermi-gas-model functions. Using first-order perturbation theory and keeping only lowest-cluster-order contributions, the coefficients of the linear combinations are determined for Hamada-Johnston(HJ), Brueckner-Gammel-Thaler (BGT), Gammel-Christian-Thaler(GCT), and Ohmura-Morita-Yamada(OMY) potentials. The bremsstrahlung-weighted cross section, σ_{-1}, is calculated with the "unperturbed" wave function $F\Phi_0$; here first-order cluster correlations are included. The first energy moment σ_1 of the cross section is also evaluated using $F\Phi_0$, but keeping only lowest cluster contributions. Variation of these three energy moments of $\sigma(w)$ with an inverse range parameter γ in f and with the nuclear radius parameter r_0 is studied. It is found that σ_0 and σ_1, which depend explicitly on the 2-nucleon potential and are sensitive to the short-range behavior of f, are substantially increased, and σ_{-1}, which is sensitive to the long-range behavior of f, may be appreciably diminished, compared to their respective values for a Fermi-gas model and well-behaved central potentials fitting the low-energy scattering data. Again, the CBF method is used to estimate the energy per particle of a neutron gas, in lowest cluster order. Both $E^{(0,1)}$ and $E^{(0,2)}$, respectively the energy in first perturbative order and second-order perturbative correction, are calculated for HJ, BGT, and Breit potentials. The behavior of $E^{(0,1)}$ vs density and the parameter γ in f is investigated. The effective mass approximation is also studied. The results show no evidence for a bound state of the extended neutron system under nuclear forces alone. Numerical values of $E^{(0,1)}$ are in agreement with other theoretical calculations at low densities. The magnitude of $E^{(0,2)}$ compared to that of $E^{(0,1)}$ points to fairly good convergence of the CBF version of the Rayleigh-Schrödinger perturbation expansion in zeroth cluster order. The application of a combined Wu-Feenberg, CBF method to interesting new types of extended nuclear matter, in particular, a mixture of α's and unclustered nucleons, is projected. (Diss. Abstr.)

17431 GENERALIZED PAIRING FORCES IN NUCLEI. Nachamkin, Jack. Troy, N. Y., Rensselaer Polytechnic Inst., 1964. 178p.

Thesis.

The formalism required for the study of pairing effects in nuclei is extended to the 2s−1d shell. Using the usual definition of the pairing operator in the L-S coupling scheme, the standard transformation from L-S to j-j coupling is employed to derive the form of the pairing operator in the presence of nucleon pairs with any possible isotopic spin. The methods of second quantization are used throughout to display the pairing operator in its simplest form. Degenerate models for nuclei having two and four nucleons beyond a double closed shell are investigated. The formalism for the nondegenerate model is developed within the frame-work of the shell model. The P_2 or quadrupole force is introduced by assuming that, to lowest orders, the effect of this force is to deform the nuclear potential in the manner dealt with by Nilsson. To do this, a formalism is developed which bears close resemblance to the formalism in the non-deformed case. In the simple cases treated there seems to be good qualitative agreement with experiment. Many more experiments are needed, however, to fill the many gaps in the experimental data. (Diss. Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 16041, 16337, 16561, 16584, and 17273.

17432 (AECL-2549) FINAL REPORT ON SHAFT SEAL DEVELOPMENT. Billington, I. J.; Fitzsimmons, T. E. (Dilworth, Secord, Meagher and Associates Ltd., Toronto (Ontario)). Nov. 1965. Revised Mar. 1966. 26p. (DSM-203-358(Rev.)). Dep. mn. AECL $1.00.

A coolant pump shaft seal development program is summarized; particular reference is made to the final endurance test series on hydrostatic, self-energized, finite clearance, seals. Results of 28,000 hours of testing, including 10,000 hours operation in pH 10 water are discussed. The endurance test program resolved the selection of seal geometry and materials. Critical inspection of a seal after 5,000 hr of operation indicated very low wear rate and slight surface changes, but no trend toward increased leakage or increased power requirement. A self-energized seal was installed in a primary coolant pump of the NPD Reactor. (auth)

17433 (APDA-302) RESULTS OF THE LOW-POWER NUCLEAR TEST PROGRAM FOR THE ENRICO FERMI FAST BREEDER REACTOR. Ball, George L.; (and others) (Atomic Power Development Associates, Inc., Detroit, Mich.). Feb. 1967. Contract AT(11-1)-865. 128p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Procedures and results of the low-power nuclear test program for the first core loading of the Enrico Fermi fast breeder reactor are summarized. Included are (1) a description of the reactor proper, along with its auxiliary equipment and instrumentation; (2) the background and objectives of the nuclear testing effort; (3) the test procedures; and (4) the actual test results as well as a comparison of these results with previously predicted values. Where applicable, the test results are evaluated in terms of realization of the objectives, use and application in future test programs, and accuracy. (auth)

17434 (APDA-CFE-1) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 1, August 1966. McCarthy, J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Dec. 1966. Contract AT(11-1)-865. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

During July the reactor was operated two days at 67 MW(t), four days at 100 MW(t), and four days at less than 1 MW(t). Scheduled testing at 67 MW(t), 2-loop operation, was completed except for oscillator tests with automatic feedwater control. The 100-MW(t) operation was with all three primary and secondary Na loops in service. Test procedures at 100 MW(t) completed include oscillator tests, a heat balance measurement, a safety rod drop test, and a power coefficient measurement. Difficulty with steam generator stability was encountered as the reactor power was increased and the corresponding steam generator conditions reached the production region for superheated steam. Superheat was obtained by decreasing the steam pressure or increasing the steam generator Na outlet temperatures. During August the reactor was operated four days at 100 MW(t), four days at 67 MW(t), and one day at less than 1 MW(t). Pulse, noise and setback tests were made at 100 MW(t), then the reactor was operated for 60 hours at 100 MW(t) and generated 22 MW(e) for 53 hours. This represents the first electrical output from the reactor plant. The operation was very stable. One purpose of the 60-hour run was to obtain information on plant systems and equipment such as shield temperatures, Na and gas purity, equipment temperatures and component movements, radiation levels, and gas leakage. Results were generally as expected. The 100 MW(t) run was terminated twelve hours ahead of schedule because of a high H_2 level in a steam generator, caused by leaks at the water tube sheet. Stainless steel-sheathed, MgO-insulated, tip-grounded iron-constantan thermocouples for water and steam temperature measurements were installed. Two-loop, 67-MW(t) operation checked out the steam generator Na temperature detector modifications providing signals to the automatic feedwater control system. Revised feedwater control programs were run to investigate the controllability of the rate of change of steam temperature upon superheating and desuperheating the steam generators. In addition, the reactor was operated with maximum Na flow through the blanket subassemblies and it was determined that the temperature differential between the transfer rotor container top head and the upper reactor vessel shell was substantially reduced. This differential has been exceeding expectations. (J.R.D.)

17435 (APED-5177) LIQUID/VAPOR ACTION IN A VESSEL DURING BLOWDOWN. Moody, F. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). June 27, 1966. 52p.

Vapor bubble rise forms the basis for a theoretical study of liquid/vapor action in a saturated system during blowdown. Methods are developed and demonstrated for predicting time- and space-dependent mixture properties. Graphs are presented for estimating the time-dependent mixture level during steam, water, and mixture blowdowns from 1000 psia. Theoretical mixture levels are compared with vapor blowdown experiments. Although calculations strongly depend upon bubble rise velocity in the liquid, reasonable agreement with data is shown. (auth)

17436 (APED-5286) DESIGN BASIS FOR CRITICAL HEAT FLUX CONDITION IN BOILING WATER REACTORS. Healzer, J. M.; Hench, J. E.; Janssen, E.; Levy, S. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1966. 37p.

A new design basis for predicting the critical heat flux in boiling water reactors was developed. The design basis is formulated on extensive tests with multirod geometries which accurately duplicate the reactor fuel assembly flow conditions. The test results were employed to formulate limit lines which fall below the experimental data. An analytical model to predict local flow and steam quality in complex geometries was also developed. The model was applied to the reactor fuel assemblies and to the multirod test sections to show that the test sections satisfactorily mockup the in-reactor behavior. (auth)

17437 (BMwF-FBK-66-13) SYSTEMATISCHE UNTERSUCHUNG DER REGELSTABANTRIEBE VON KERNREAKTOREN. (Systematic Investigation of Control Rod Drives of Nuclear Reactors). Steil, H.-J. (Technische Hochschule, Brunswick (West Germany). Institut fuer Feinwerktechnik und Regelungstechnik). May 1966. 120p. (In German). DTIE.

The study is confirmed to the most used types of power reactors: gas-filled reactors, pressurized water and boiling water reactors. The control rod drive mechanisms are classified to their principle of design in: magnetic jack-, rack- and pinion-, lead screw-, cable hoist-, pneumatic or hydraulic piston rod drive. Each groups' construction and operation is explained by examples. Useful drives for boiling water reactors have proved to be hydraulic or pneumatic rod drives, for gas-filled reactors cable hoist type rod drives, for pressurized water reactors and with certain qualifications also for boiling water reactors magnetic jack-, rack- and pinion- and lead screw rod drives. Advantages and disadvantages of each type are represented. (auth)

17438 (CONF-660930) NUCLEAR POWER BRIEFING FOR THE COAL INDUSTRY, SEPTEMBER 29–30, 1966, OAK RIDGE, TENNESSEE. (Oak Ridge Operations Office (AEC), Tenn.). Feb. 1967. 208p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Summaries of papers given at the briefing are presented. Five presentations on fuel for nuclear power plants were included in the first session. Four presentations on current development and future prospects of nuclear power were included in the second session. Two presentations and a panel discussion were included in the last session. (J.R.D.)

17439 (EUR-3141.e) PLUTHARCO: A PLUTONIUM, URANIUM, THORIUM ASSEMBLY REACTIVITY CODE. PHYSICAL CONCEPTS, COMPARISONS WITH EXPERIMENTS AND CODE DESCRIPTION. de Haan, W.; Meelhuysen, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 25, 1966. 127p. Dep. mn.

In the framework of the ORGEL reactor physics development program, a new method for heavy water lattice calculations has been established. This method is intended for design survey type calculations and for preliminary fuel cycle analysis. Lattices fueled with U, Th, and Pu can be investigated. The method is based on the four factor formula, the two group theory and the Westcott cross-section formalism. The method has been written in Fortran II for the IBM-7090 computer, with the name PLUTHARCO (PLutonium, Uranium, THorium Assembly Reactivity COde). The code gives directly with the results the input data for RLT-4 burn-up calculations. (auth)

17440 (EURAEC-1324) HEAT TRANSFER AND FLUID FLOW CHARACTERISTICS IN A PRESSURIZED WATER REACTOR. Quarterly Progress Report No. 3, July 1, 1964–October 1, 1964. (Technische Hogeschool, Eindhoven (Netherlands)). Jan. 1965. Contract 011-64-1TEEN(RD). 19p. (EUR-2306). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The main activities consisted of making changes in loop construction and instrumentation in order to improve the loop behaviour and operation characteristics. New ion-exchangers have been installed together with a new regenerative and a non-regenerative cooler. De-aeration equipment has been added to the loop in order to control the O_2-content of the primary coolant. A by-pass has been made from the top of the test section to the suction side of the pump in an attempt to eliminate some regions of stagnant water and pressure pulses. The operation of the water treatment equipment is controlled by a differential pressure gauge and a temperature limit switch. A new thermocouple design measuring the temperature on the inside of a heating rod works quite satisfactorily. The loop was in operation for checking the over-all behaviour, while at the same time recirculation measurements have been carried out on the steam generator. A theoretical study has been started on the hydraulic coupling of parallel channels in the test section. In this study the transverse transport of fluid and vapour across the boundaries of a unit channel of a cluster fuel element are attributed to (a) a diffusion across these boundaries caused by differences in velocity, temperature and steam quality in neighbouring channels (b) pressure differences in neighbouring channels. Expression for these transverse velocities has been derived. A digital computer programme is being prepared. (auth)

17441 (EURAEC–1553) DESIGN OF A PRESTRESSED CONCRETE PRESSURE VESSEL FOR A 100 MWe BOILING-WATER REACTOR. Quarterly Report No. 1, July 1–October 20, 1965. (Societe d'Etudes et d'Equipments d'Entreprises, Paris (France). Societe Bertin, Paris (France). Societe Fives-Penhoet, Paris (France)). Contract 068-65-7-TEEF(RD). 30p. (EUR–2695). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Research on the feasibility of construction and use of prestressed concrete pressure vessels for 1000 MW(e) boiling reactors is described. The first-stage research work is reported and is concerned with pressure vessel optimization. Calculation results on pressure vessel cost are presented as a function of internal pressure, shape, and dimensions. Calculations of failure are also included. Concepts for pressure-vessel cooling circuits are discussed. (J.R.D.)

17442 (EURAEC–1594) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Quarterly Report No. 7. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Jan. 1, 1966. Contract 101-63-11-RD I. 8p. (EUR–2815). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Activities in a program to gain operating experience and experimental results for evaluating power-limiting features of the Garigliano power plant are summarized. Information is included on computerized data logging system, insertion of instrumented assemblies in the reactor, and gamma scanning of fuel elements. (J.R.D.)

17443 (EURAEC–1610) CRITICAL FLUX IN A 9-ROD TWISTED TAPE CLUSTER. Special Report No. 23. (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Suresnes (France). Division Atomique). Feb. 11, 1966. Contract 061-64-7-TEEF(RD). 8p. (EUR–2823). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The localization of burnout in a test section of 9 stainless steel rods with a geometry similar to that of a boiling water reactor fuel element was investigated. Power was supplied by electrically heated stainless steel twisted tapes tangent to the rods. Results are presented for critical heat flux variation in relation to coolant fluid entry and exit qualities. (H.D.R.)

17444 (EURAEC–1688) STUDY OF A PRESTRESSED CONCRETE CAISSON FOR A 1000 Mwe BOILING WATER REACTOR. Quarterly Report No. 4, April–June 1966. (Societe Bertin, Paris (France). Societe d'Etudes et d'Equipments d'Entreprises, Paris (France). Societe Fives-Penhoet, Paris (France)). July 1966. Contract 068-65-7TEEF. 7p. (EUR–2875). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The present status of the studies is given. The decisions taken at meetings held during this quarter regarding the action taken on these studies are presented. (tr-auth)

17445 (EURAEC–1782) HIGH VOID TESTS AT THE GARIGLIANO NUCLEAR POWER STATION. Santasilia, Franco (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Oct. 1966. Contract 101-63-11-RDI. 77p. (EUR–3324). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of a special program to determine critical parameters for operating conditions in excess of normal are given for the Garigliano Nuclear Power Station. Stability and thermal performance of the reactor are examined under severest operating conditions. Performance of auxiliary systems, data acquisition assemblies, and coolant systems is discussed. (M.L.S.)

17446 (EURAEC–1793) RESEARCH PROGRAM FOR THE GARIGLIANO NUCLEAR POWER PLANT. Quarterly Report No. 11. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Jan. 1967. Contract 101-63-11-RDI. 9p. (EUR–3333). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Activities under three tasks of the Research Program are very briefly summarized. (H.D.R.)

17447 (GA–7482) HIGH-TEMPERATURE GAS-COOLED REACTOR FUELS AND FUEL CYCLES: THEIR PROGRESS AND PROMISE. Jaye, S.; Goeddel, W. V. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 10, 1966. Contract AT(04-3)-633. 30p. (CONF-661001-45). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

The fuel and fuel cycles of high-temperature helium-cooled reactors are examined. The requirements placed on the fuel container, how these requirements have been achieved, several potentially attractive fuel cycles, and some likely fuel cycle costs in large HTGRs are discussed. (M.L.S.)

17448 (GEAP–4974) 600 MWe HIGH POWER DENSITY BWR CORE-CONCEPTUAL DESIGN. Final Report. Miller, D. R.; Roberts, J. M.; Worthington, J. T. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1966. Contract AT(04-3)-361. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The selection and analysis of a high power density, 1915 MW(t), boiling water reactor core is presented. The core utilizes fuel bundle designs similar to designs currently being tested at Big Rock Point. Design criteria are established consistent with current or projected design practices with an effort made to avoid radical new concepts which might compromise the feasibility of the design. (auth)

17449 (GEAP–5279) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 6, July–September 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1966. Contract AT(04-3)-189. 110p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tentative distributions are proposed of the real variations and of the uncertainties in the parameters affecting low-cycle metal fatigue failures. Equations were developed for cycles required to grow cracks through pipe walls, and for the variance of cycles to failure. Fatigue test results, which typically vary widely, are shown to be the largest contributor to the variance. Computer Code development continued with checkout progressing satisfactorily. This included work on the solution, stress, and preprocessor portions of the program. Nitrided WOL (Manjoine) specimens of low-C steel (cold-rolled, commercial grade) were tested at –195° to 81°C. As a part of the fracture toughness studies, the critical stress intensity factor, K_{IC}, calculated for each test temperature, showed a smooth increase with temperature. Results showed no difference between the nitrided material and controls which were not nitrided, provided only the second crack (pop-in) was considered. The first crack starting in the nitrided surface material yielded a different fracture toughness than the controls. Measurements of microhardness gradients across crack tip plastic zones in Type 304 stainless steel showed too much scatter to permit quantitatively mapping the plastic energy distribution about the crack tips. Charpy impact tests, both longitudinal and transverse, were made of the A-106B plain carbon steel piping to be used for the prototype pipe test specimens. A difference was revealed in the transition (50% FATT) temperature in the two directions ranging from 50 to 90°F with the transverse specimens (which yield a radial or axial crack with respect to the pipe), and from 20 to 50°F, in the longitudinal specimens (which yield a transverse or circumferential crack with respect to the pipe). Results obtained in the analysis of a circumferential through-wall crack in 6- and 24-inch pipe enable application of brittle fracture mechanics theory to a geometry not previously analyzed. Crack growth rate measurements were started in C steel plate speci-

mens at 600°F. These tests are the first in the series intended to determine the effect of loading rate and hold time as well as the effect of higher temperature. Electron microfractography examinations of the fatigue fracture surfaces of specimens tested earlier yield excellent agreement with the crack growth rates measured by the macroscopic marker technique. A design analysis was done covering the crack initiation stage of failure of the initial prototype pipe specimens. It was determined that deflection control was most suitable– rather than strain or load control for the prototype fatigue tests. Also strain gage locations have been specified. (J.R.D.)

17450 (HIT–3583-43(Vol.1)) LOW ENRICHED PM REPLACEMENT CORE. VOLUME I. Final Design Report. Baer, Robert (Hittman Associates, Inc., Baltimore, Md.). Nov. 28, 1966. Contract AT(30-1)-3583. 178p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The core mechanical design, nuclear characteristics, and thermal-hydraulic performance are described. Analyses performed on the core such as those concerning fuel element analysis to establish tolerances and adequacy of the fission gas retention volume are described. The basis for control rod design is discussed. Analyses of the core nuclear characteristics revealed that power distributions are thermally acceptable throughout core life. Analyses of costs revealed that the core costs less than the previous fully-enriched PM cermet cores. (J.R.D.)

17451 (HIT–3583-43(Vol.2)) LOW ENRICHED PM REPLACEMENT CORE. Final Design Report. Baer, Robert (Hittman Associates, Inc., Baltimore, Md.). Dec. 20, 1966. Contract AT(30-1)-3583. 97p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information and data related to HIT-3583-43(Vol. 1) are presented as appendixes concerned with core stress analysis, fission gas pressure, burnable poison element particle self-shielding, calculation of reactivity coefficients, fuel pellet thermal expansion, temperature distributions, and analog study equations and constants. (J.R.D.)

17452 (IITRI–578P21-25) STUDIES OF REACTOR CONTAINMENT. Bimonthly Progress Report, October 1–November 30, 1966. Gallagher, E. V.; Zaker, T. A.; Wiedermann, A. H. (IIT Research Inst., Chicago, Ill.). Contract AT(11-1)-578. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of analyses and calculations are presented of nonsteady and quasisteady decompression of saturated water. Experimental results and data related to decompression in water shock tubes are included. (J.R.D.)

17453 (KAPL-M–6588) SOME MATHEMATICAL PROPERTIES OF THE MULTICHANNEL VARIATIONAL SYNTHESIS EQUATIONS AND TWO-DIMENSIONAL SYNTHESIS NUMERICAL STUDIES. Wachspress, E. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 12, 1966. Contract W-31-109-eng-52. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

It is proved that the matrix approximating the group diffusion operator $(-\nabla \cdot D\nabla + A)$ in the multichannel variational synthesis mockup is positive definite. Some numerical studies of a highly nonseparable reactor are described. (auth)

17454 (KFK–448) STATISCHER UND DYNAMISCHER NEUTRONENFLUSS: EINE UNTERSUCHUNG DER UNTERSCHIEDE. (Statistical and Dynamic Neutron Flux: An Investigation of the Distinction). Schubert, D. (Kernforschungszentrum, Karlsruhe (West Germany). Inst. fuer Angewandte Reaktorphysik). July 1966. 18p. (In German). Dep. mn.

The distinction between dynamic and static flux distribution was investigated as a function of the reactor period T using as an example a fast Na-cooled breeder reactor. Both the variation of the fission source term and of the effective absorption cross section with T was considered. The results show that the effect of the dependence of the source term T on the flux distribution can be neglected for all T. Also the effect of the supplementary absorption term $1/vT$ on the flux distribution can be neglected for $T > 10^{-3}$ sec., therefore for fast reactors $\phi_s = \phi_d$ can be assumed. For a shorter reactor period the $1/vT$ term is very noticeable. It leads to a hardening of the spectra increasing with decreasing T and to a concentration of the low energy flux at the inner zone of the reactor. This variation of the flux distribution must be considered because of its effect on the neutron life and the Doppler coefficients in the safety calculations for prompt-supercritical excursions in fast reactors. The approximation $\phi_d = \phi_s$ may not be assumed here. (tr-auth)

17455 (KFK–462) DAS PROGRAMMSYSTEM TERM-1. (The Program System TERM-1). Gmelin, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug. 1966. 70p. (In German). Dep. mn.

The TERM-1 program was developed for the time monitoring of the Karlsruhe fast breeder project. The fundamentals of the network-planned technique, on which the TERM-1 program is based, were described and illustrated on the basis of some examples of the input and output conventions in the operation of the TERM-1 program. In the appendix the calculation of a network plan, the flow diagram, and the program list of the TERM-1 are given. (J.S.R.)

17456 (LA-DC-8288) WHY COUPLED FAST BREEDER REACTORS? Hannum, W. H.; Prabulos, J. J. Jr. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 11p. (CONF-670107-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

Many observations have been forwarded in support of coupled reactors. Some of these are valid for central-station fast breeders. The incentives, other than safety, for going to a modular or other coupled arrangement are small, except in cases where extensive neutron spectrum tailoring is needed. Some caution is required in utilizing the attractive reactivity coefficients of a coupled system to ensure that they are valid throughout the reactor cycle. (auth)

17457 (LA-DC–8299) HIGH FREQUENCY TRANSFER FUNCTION MEASUREMENTS FOR COUPLED FAST POWER REACTORS. Anderson, Carl A. Jr. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 42p. (CONF-670107–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

The reasons for, and problems of, measuring transfer functions of fast power reactors in general are discussed with emphasis on the need for measurements of coupled fast power reactor transfer functions in the high frequency domain. The measuring techniques are analyzed; use of an intense pulsed neutron source is found to be of particular interest. (auth)

17458 (LA-DC–8352) STATE-VARIABLE FEEDBACK CONTROL OF COUPLED NUCLEAR SYSTEMS. Murray, Hugh S. (Los Alamos Scientific Lab., N. Mex.); Melsa, James L. (Arizona Univ., Tucson). [1967]. Contract W-7405-eng-36. 21p. (CONF-670107–5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

The advantages of state-variable feedback control is presented. Great flexibility in the method may specify exactly the desired system response subject to the constraints imposed by the internal variable behavior. The resultant systems do not in general exhibit stability problems with increases in gain, and the designed system can be made relatively insensitive to the gain. The fact that delayed neutrons are ignored distracts from the reality of the results. Some useful results such as those which arise from the consideration of cores with temperature effects and from the examination of multicore systems appear. If delayed neutrons are included in the reactor dynamics, they are in inaccessible states, since the precursor density cannot be measured. These state variables may be generated from their describing equations. In conventional compensation designs, networks must be designed, and since the structure of state-variable feedback controllers is uncomplicated to begin with, the addition of the minor loops required for state-variable generation is not a serious problem. (auth)

17459 (NAA-SR–11378(Vol.1)) FEASIBILITY STUDY OF A 1000-Mwe SODIUM-COOLED FAST REACTOR. VOLUME I. TECHNICAL AND ECONOMIC POTENTIAL. (Atomics International, Canoga Park, Calif.). July 1966. Contract AT-11-1-GEN-8. 361p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results of a feasibility study of a 1000-MW(e) Na-cooled fast-reactor are presented. Different coupled-core configurations with varying geometric arrangements of fast and blanket regions are studied including cylindrical cores with internal fast regions and integral- or reflector-moderated blanket regions; annular fast-region cores with integral- or reflector-moderated inner and outer blanket regions; and modular cores with multiple fast and reflector-moderated blanket regions in a modular array. For suitably coupled cores, Doppler reactivity effects are made more negative by increasing the proportion of power extracted from the blanket regions. Na void reactivity effects are made more negative by increasing core peripheral areas and thus increasing neutron leakage into blanket regions. A reference design is presented which has improved safety characteristics compared with present fast reactor designs, and comparable economics. The design is a modular flux-trap reactor which extracts approximately 40% of the power from the blanket regions. The isothermal Doppler coefficient of reactivity ($-T\,dk/dT$) is –0.018, and the Na void reactivity effect is negative for most conditions of core or blanket Na voiding. A breeding ratio of 1.31 is obtained with fuel cycle costs

of 0.67 mills/kWh for $10/g Pu, 80% load factor, and 10% interest charges on inventory. The reference design uses mixed-oxide fuel. An alternative oxide core arrangement is presented which has improved economics but less conservative safety criteria than the reference design. Also included are the results of a carbide core study which show that a mixed-carbide modular flux-trap reactor designed for high power density has considerable long-term potential for improved economics and safety compared with the reference oxide design. (auth)

17460 (NAA-SR-Memo-3697) THE PROBLEM OF CORE GRAPHITE CONTAMINATION BY SODIUM IN A CALANDRIA TYPE SGR. Carter, Robert L. (Atomics International, Canoga Park, Calif.). 1957. Contract AT(11-1)-Gen-8. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data have been collected permitting a fairly definitive correlation to be made between sodium vapor pressure over graphite and equilibrium sorption of sodium on graphite. These data show conclusively that sodium is transferred through the vapor phase from a communicating sodium surface whose temperature may be depressed as much as 250°F below the temperature of the graphite. The process appears to be reversible. The kinetics of this process have not yet been studied in detail, although preliminary results show rates which seem surprisingly slow. Data on gaseous diffusion through graphite pore structure may be employed to predict maximum permeation rates, and may be compared to data for interaction and for subsequent removal of sodium by diffusion. The observed reaction rates are several orders of magnitude lower. The correlation between physical dilation and quantity of sodium adsorbed is found to be approximately linear, being approximately one volume per cent, per weight per cent sodium. A calculation of the macroscopic neutron absorption permits a graphical description of the point at which effect of the presence of sodium-vapor upon neutron economy becomes detrimental. The consequence of a flaw in the protective system separating a graphite volume from a sodium-vapor contaminated gas will be a rapid filling of the 25% accessible void volume of all communicating graphite with the gas. Sodium vapor passing into the graphite will be slowly "fixed" by reaction with the graphite, after which it cannot readily be removed by gas flushing. The temperature dependence of the vapor exposure parameter will lead to a very gradual concentration of sodium within the lower temperature graphite at the bottom of the reactor core. It is possible, in principle, to remove the adsorbed sodium after repairing the flaw, by raising the graphite temperature and flushing with sodium free gas. Exposure of graphite to sodium under conditions of a sodium vapor exposure parameter, $(T_c - T_{Na})/T_{Na}$, which is 0.2 or greater results in equilibrium dilation of only 0.2% and an increase in microscopic neutron absorption cross-section of graphite by less than 10%. This condition could be imposed by deliberately providing an exposed cold free sodium surface and arranging to insure that the coldest reactor graphite is at all times at least 150°F higher in temperature than the exposed free sodium surface. (auth)

17461 (NAA-SR-Memo-6759) THE DETERMINATION OF SLIDING COEFFICIENT OF FRICTION WITH SANTOWAX "R" AS A LUBRICANT. Ballif, J. L. (Atomics International Canoga Park, Calif.). Oct. 25, 1961. Contract AT-11-1-GEN-8. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Santowax R was evaluated as a coolant for the Prototype Organic Power Reactor (POPR). Results of tests performed on a NAA built sliding friction machine, using Santowax R as a lubricant with chrome plated H-11 tool steel top specimens and bare M-2 tool steel bottom specimens, are presented. The lubricating value of Santowax R (coefficient of friction) at loads from 137 to 637 psi at 400°F tended to be slightly better than bare surfaces. The lubricating value of Santowax R (coefficient of friction) at loads of 137 to 637 psi at 550°F tended to decrease as a function of the load. The lubricating value of Santowax R, judged by a change in the coefficient of friction, tended to increase at 700°F regardless of the load because of the pyrolitic decomposition of the organic coolant which provided a carbonaceous sliding surface film. The basic conclusion, however, was that Santowax R was not significantly better than a bare surface. Therefore, it is recommended that design be based on the bare surface coefficient of friction. The small lubricating value at operating temperatures would then be a factor of safety acting on the conservative side. No attempt has been made here to assess the detrimental aspects of the radiolytic or pyrolitic decomposition of the organic upon the mechanism itself. A NAA proprietary lubricant, Vitrolube 1207C, (MoS_2, plus a number of other ingredients) was tested and showed a low coefficient of friction but was attended by lubricating film wear that would disqualify it at the loads or temperatures of interest in this work. (auth)

17462 (NP-16146(Suppl.1)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 1. (Florida Power and Light Co.). [1966]. 72p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Supplementary data to the Oceanography Section and the Containment Section of the Preliminary Safety Analysis Report are presented. (H.D.R.)

17463 (NP-16146(Suppl.2)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 2. Fullerton, R. C. (Florida Power and Light Co.). Aug. 11, 1966. 176p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Additional information on the preliminary safety analysis is presented in the form of answers to forty questions submitted by the Director of Reactor Licensing. (H.D.R.)

17464 (NP-16146(Suppl.3)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 3. Keck, J. W. (Florida Power and Light Co.). Sept. 1, 1966. 164p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Additional information on the preliminary safety analysis is presented in the form of answers to six questions submitted by the Director of Reactor Licensing. (H.D.R.)

17465 (NP-16557) ISPOL'ZOVANIE REAKTOROV TIPA BELOYARSKOI AEC DLYA DVUKHTSELEVYKH OPRESNITEL'NYKH USTANOVOK. (Utilization of the Beloyarsk Atomic Power Station Reactors for Dual Purpose Desalination Installations). Koryakin, Yu. I.; Loginov, A. A.; Mikhan, V. I.; Monchinskii, A. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 1966. 12p. (In Russian). Dep. mn.

An evaluation of the energy possibilities and economic indicators of reactors of the Beloyarsk type give a basis for the calculations of these reactors for combined production of electrical energy and fresh water, especially under conditions where these two forms of production are equally important and necessary. (tr-auth)

17466 (ORNL-P-1798) VELOCITY MEASUREMENTS FOR BEDS OF LARGE, UNIFORM-DIAMETER SPHERES PACKED IN A FULL-SCALE MODEL OF A PEBBLE-BED NUCLEAR REACTOR. Bundy, R. D.; Hoffman, H. W. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 42p. (CONF-660302-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 3rd Southeastern Conference on Theoretical and Applied Mechanics, Columbia, S. C.

Velocity profiles were determined for shallow beds of randomly packed spheres to provide information needed in the thermal analysis of pebble-bed nuclear reactors such as the Pebble-Bed Reactor Experiment (PBRE). Concurrent measurements of the void fraction and superficial angle of repose for these beds supplied data useful in the interpretation of the velocity profiles. The beds examined were formed of $1\frac{1}{2}$-in.-diam graphite spheres packed by various techniques in a full-size, Plexiglas, PBRE core model having approximately a conical bottom and a cylindrical body. An upward air flow simulated the He reactor coolant. Point velocities were obtained above the exit face of the bed with a hot-wire anemometer. Bed configurations included complete beds capped by fill cones and flat-topped arrangements of several depths. (auth)

17467 (PRWRA-104) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 9. (Puerto Rico Water Resources Authority, San Juan). Sept. 1966. Contract AT(40-1)-2672. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Efforts to obtain low friction performance of the control rod drive water seals and, thus, good control rod scram times was the main plant activity during September, 1966. Means of reducing the friction between the floating rings and diaphragms of the water seal assemblies were investigated. The use of teflon wafers was explored with very good results. Tests in which the reactor was pressurized while having two of the control rod water seals equipped with teflon wafers between the floating rings and the diaphragms were conducted. Further information is required to completely evaluate the applicability of teflon wafers to the BONUS control rod water seals. Tests of the water seals are described. Modifications made to the plant design and changes in the Technical Operating Procedures Manual are included. (J.R.D.)

17468 (RISO-M-496) FUEL LEAKAGE DETECTION IN WATER REACTORS. A Review. Teodosic, Vlada (Danish Atomic Energy Commission, Risoe. Research Establishment). Dec. 1966. 33p. (R-9-66). Dep. mn.

A general review of failed element detection and location systems for water-cooled reactors, with a particular attention to the DK-400 project is presented. Release ratios ρ, signal to background ratios D, and discrimination ratios R are discussed and evaluated, and a description of existing FEDAL systems is given. The influence of the state of the reactor core on important parameters for a FEDAL system is discussed in appendices. (auth)

17469 (RT-FI-(66)-13) CONVEGNO DI FISICA DEI REATTORI, C.S.N. CASACCIA, 15-16 SETTEMBRE 1965. (Proceedings of the Conference on Reactor Physics, Casaccia Center of CNEN, Italy, September 15-16, 1965). (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 113p. (In Italian). (CONF-650982). Dep. mn.

Papers were presented by the representatives of organizations which deal in Italy with reactor physics problems. (tr-auth)

17470 (RT-FI-(66)-16) CONFRONTO TEORIA-ESPERIENZA NEL CALCOLO DELLE BARRE DI CONTROLLO DEL REATTORE DEL GARIGLIANO. (Comparisons of Theoretical and Experimental Data on the Control Rods in Garigliano Reactor (Water Moderated UO_2 Reactor). Manca, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 31p. (In Italian). Dep. mn.

The application and validity of some methods used in control rod calculations in light water moderated UO_2 thermal reactors are studied. The comparison between theory and experience is made by utilizing data obtained from the Garigliano reactor. (tr-auth)

17471 (UJV-1616) RASCHET EFFEKTIVNOSTI SISTEMY CHASTICHNO POGRUZHENNYKH STERZHNEI. (Calculation of Efficiency of Partially Submerged Rod System). Cermak, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 24p. (In Russian). DTIE.

The work of previous investigators on the efficiency of partially submerged control rods is generalized to the case of general nonsymmetric distribution of the control rod in a reactor with reflector. The proposed method makes it possible to determine, together with the critical Laplacian, the distribution of the density of thermal neutrons and the density of the delayed fast neutrons in the vicinity of the control rod channels. The size of these densities can be obtained at any point of the reactor. Examples of the numerical calculation are given. (tr-auth)

17472 (WCAP-2987) EFFECT OF THE MODERATOR COEFFICIENT ON CORE STABILITY. French, R. J.; Strawbridge, L. E.; Barry, R. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Sept. 1966. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An analytic model is developed to evaluate the effect of the moderator temperature coefficient on core stability. The model includes the effects of delayed neutrons, the delay times for heat transfer in the fuel and coolant and the interaction of flow changes on spatial stability. A stability criterion is derived from this model. The magnitude of the moderator temperature coefficient which results in an unstable core condition is expressed in terms of the Doppler coefficient, core leakage, and thermal and hydraulic parameters. When conservative values are used for the nuclear, thermal, and hydraulic parameters, the threshold moderator coefficient in a large high-performance PWR is estimated to be $+1.5 \times 10^{-4}$/°F. (auth)

17473 (WCAP-3269-63) FISSION PRODUCTS FROM FUEL DEFECT TEST AT SAXTON. Fletcher, W. D.; Picone, L. F. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Apr. 1966. Contract AT(30-1)-3269. 54p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An intentional fuel cladding defect was placed in the Saxton Nuclear plant and the reactor operated at and near full power during a calendar period of 57 days. Primary coolant samples were analyzed for fission products and escape rate coefficients for the I_2 and fission gases were estimated therefrom. The calculated escape coefficients (υ) for I_2 are 2×10^{-9} sec^{-1}, 8×10^{-9} sec^{-1}, and 14×10^{-9} sec^{-1}, for ^{131}I, ^{133}I, and ^{135}I respectively. Fission gas ^{133}Xe and ^{88}Kr indicated average υ's of about 25×10^{-9}. (auth)

17474 (WCAP-3680-1) CONTROL OF XENON INSTABILITIES IN LARGE PWR'S. Technical Progress Report for the Period Ending September 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1966. Contract AT(30-1)-3680. 18p. (EURAEC-1721). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Studies performed have demonstrated that the selected calculational procedures are acceptable for the initial phases of the program. An x-y calculation without Doppler damping was performed for a large PWR core to establish the characteristics of a free-running, divergent oscillation. This calculation was carried through several cycles of the Xe oscillation so that the rate of divergence could be determined. The x-y case seems to be less stable than expected. Comparisons of predicted Xe stability in the x-y plane were then made for full-core calculations, full-core calculations with 45° symmetry, and half-core symmetric calculations. From these comparisons it appears possible to perform some of the analyses with symmetric calculations which reduce computer running time. For corrective control action, however, full-core calculations will probably be required. A calculation that included a pointwise Doppler coefficient was also performed to observe its stabilizing effect. However, this calculation required an excessive amount of computer time, and alternate calculational approaches are being considered. (auth)

17475 (WCAP-3696-1) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Technical Progress Report for the Period Ending September 30, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1966. Contract AT(30-1)-3696. 51p. (EURAEC-1723). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Tests were conducted at the Saxton Reactor which included power swings at different pH conditions. In support of these tests calculations of the Xe behavior during the experiment were carried out. Dynamic measurements performed during the Saxton tests indicate that the pH-reactivity effect is associated with power defect. Calculations were carried out to determine the reactivity effect of a uniform deposit of Fe_3O_4 in the Yankee and Saxton cores. The results indicate that 1000 mg/dm^2 deposited or removed from the core surfaces in Saxton would explain the full typical short term reactivity changes due to pH in the Saxton Reactor, while approximately 1500 mg/dm^2 would account for the typical short term reactivity change observed in Yankee pH tests. Work was initiated on the design of an instrumented fuel subassembly for the Saxton Reactor. The feasibility of crud detection by measurement of the change in fuel centerline temperature was investigated for UO_2, cermet, and alloy fuels. Based on these calculations and on manufacturing evaluations, a UO_2-300 series stainless steel cermet was specified as the reference fuel for the instrumented rods. Preliminary UO_2 enrichments were established and vendor sources were investigated. Design work was initiated on a test section, to be used in an existing loop, for out-of-pile studies on the pH effect. Synthesized corrosion products will be injected into the test section and heat transfer measurements will be performed at various pH conditions on any deposits formed on simulated fuel rods. (auth)

17476 (NP-tr-1491) LIQUID SODIUM TECHNOLOGY AND PROBLEMS OF FAST BREEDER REACTOR DEVELOPMENT. Furukawa, Kazuo. Translated by R. A. Scutt (Atomic Energy Research Establishment, Harwell, Eng.), from Genshiryoku Kogyo, 11: No. 10, 31-7; No. 11, 53; 55-60; No. 12, 55-61(1965). 87p. Dep. mn. JCL $8.10 fs, $2.81 mf.

The following subjects are reviewed: liquid sodium technology and atomic power, history of development of sodium technology, future of sodium reactors, main problems in the use of sodium, materials for fast reactors, improvement of specific thermal output, impurities in sodium and corrosion of materials, interaction of impurities, corrosion of stainless steel, change in mechanical properties of materials, fuel canning and main structural materials, materials for steam generators, behavior of fission products in sodium, sodium apparatus and components, traps, apparatus for removing impurities, electromagnetic pumps, mechanical pumps, intermediate heat exchangers, steam generators, impurity meters, hydrogen detectors, liquid level meters, flow rate meters, problems relating to design and operation of sodium loops, sodium cooled reactors and test loops, loops for system engineering development, purity control and impurity measurement development loops, corrosion and mass transfer test loops, materials strength test loops, heat transfer and flow test loops, thermal shock test loops, the 10MW Cadarache (France) installation, the 5MW Grand Quevilly Station (France), the 5MW Interatom loop (Germany), The 35MW SCTI installation (America), sodium in-pile test loops. Recommendations are made for further work. Bibliographies are included. (UK)

17477 (ORNL-tr-1509) CIRCULAR PLANE RADIATION SOURCE BEFORE AN ABSORBING HALF-SPACE. Schultz, H.; Wueneke, C. D. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from German Report ABS-THH-1001. 40p. JCL. DTIE.

Calculation methods for use in applying reactor shielding test results obtained at existing reactors to planned facilities are described. Results are presented of computer calculations for shielding against primary gamma radiation and fast neutrons. Programs for use in the computations are described. (J.R.D.)

17478 (ORNL-tr-1519) NEUTRON FLUX MEASUREMENTS IN THE MOCK-UP OF A POWER REACTOR SHIELD IN THE LARGE IRRADIATION CHANNEL OF THE GEESTHACHT RESEARCH REACTOR (FR). Stiller, G. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National

Lab., Tenn., from report ABS-THH-1015. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $8.60 fs, $3.08 mf.

A power reactor shield mockup was investigated in the Geesthact Research Reactor. The mockup of a layered design incorporating radiation detectors is described. Types of nuclear reactions used in evaluations are also described. Data are included on the thermal and epithermal neutron flux. (J.R.D.)

17479 NEW FUEL SYSTEM FOR HIGH TEMPERATURE REACTORS. 500 MWe COMMERCIAL REACTORS SUITABLE FOR U.K. POWER PROGRAMME COULD BE BUILT WITHOUT FURTHER RESEARCH. Dean, J. R. Elec. Rev., 178: 824-6(June 3, 1966).

Data from Dragon tests show that lower enrichments of U can be used for HTGCR-type reactor fuel elements. Merits of the high temperature reactor as a power production plant are also summarized. Qualitative comparisons for HTGCR-type reactors with other types are made. (M.L.S.)

17480 SOLVING REACTOR SITING IN CALIFORNIA. Keene, Jenness (McGraw-Hill San Francisco Bureau). Nucleonics, 24: No. 12, 53-5; 68(Dec. 1966).

The choice of a site for a nuclear power plant requires study by many agencies. The Resources Agency of California cooperates with utility companies to locate a power plant—nuclear or other—to impose a minimum of ill effects on the public, on the ecology of the land and its wildlife, and on the ecology of state waters and aquatic life. The agency encourages the use of nuclear energy to provide economic benefits to the public, promote air cleanliness, and conserve fossil resources. The Pacific Gas & Electric Company was the first utility to form a liaison group between utility and conservation agencies. PG&E expects six to eight nuclear generating units in operation in California by 1980, including the Humbolt Bay Nuclear unit. (J.C.W.)

17481 OUR FAST BREEDER PROGRAM: WHERE IT STANDS AND WHERE IT IS GOING. Strauss, Sheldon D. Nucleonics, 24: No. 12, 41-7(Dec. 1966).

The U. S. government, joined by industry, is realizing its goal of developing a full nuclear power industry with the breeder reactor. The Liquid Metal Fast Breeder Reactor will attain a breeding ratio of 1.2 and produce power competitively. The fuel program stresses the development of oxides and carbides of Pu–U mixtures. The materials recommended for cladding development are austenitic stainless steel, Ni base alloys, and refractory alloys. Stainless steel is compatible with mixed oxides, has low neutron absorption and is economical. The EBR-II and Fermi reactors will provide needed irradiations to determine the fuel design parameters of the first prototype. Many facilities are to be used for physics and safety tests. After many tests in the ZPR-types, the Zero Power Plutonium Reactor will handle large Pu criticals and engineering mockups of large fast reactor cores. Na component development for large fast reactors concentrates on heat exchangers, pumps, valves, and instruments. LMFBR control requires in-core monitoring of neutron flux, coolant flow and temperature, fuel and clad temperature, and neutron spectrum analysis. With the exception of the FFTF, experiments and testing will be in the design of the prototype plants of the 1970's. (J.C.W.)

17482 ITERATIVE METHOD OF MULTI-POLE SOURCE-SINK CALCULATION. Kawashima, Kanau (Fuji Electric Co., Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 27-31(Jan. 1967).

The multipole source-sink problem was solved by iterative calculation using a computer. A general equation for the multipole source-sink problem is formulated. The dipole problem is then solved by iterative method, in which the neutron flux around each element is calculated at fictitious points surrounding the element, and the dipole sink strength is correlated to the harmonic component of the neutron flux distribution. A brief description of the computer code and the results of trial calculation are given. (auth)

17483 IODINE BEHAVIOR. Hattori, Sadao (Chubu Electric Power Co., Japan). Nippon Genshiryoku Gakkaishi, 8: 656-9(Dec. 1966). (In Japanese).

The Committee on Fission Products Release is composed of two study groups. Group A deals with fission-product behavior in the fuel and release thereof from the fuel. Group B directs its activities toward quantative evaluation of the physical and chemical behavior of fission products released into the single or mixed phases of water, steam, and air in a nuclear power plant. A brief description of some informative data from a selection of papers taken up and considered in group B is presented. (auth)

17484 STABILITY OF CIRCULATING FUEL NUCLEAR REACTOR WITHOUT DELAYED NEUTRONS. Goryachenko, V. D. At. Energ. (USSR), 21: 267-71(Oct. 1966). (In Russian).

The stability of circulating fuel nuclear reactors was studied without considering delayed neutrons but taking into account the space distribution of the variables along the reactor core. A simplified evaluation of delayed neutron effects showed their favorable influence on reactor stability. The feasibility of using Welton's criterion is discussed and it is shown that in a reactor with distributed parameters the Welton criterion does not resolve the problem. (tr-auth)

17485 THE EXPERIMENTAL ATOMIC POWER STATION OF THE ARBEITSGEMEINSCHAFT VERSUCHSREAKTOR (AVR) IN JUELICH. Cautius, Werner (Arbeitsgemeinschaft Versuchsreaktor GmbH, Dusseldorf). Brennstoff-Waerme-Kraft, 18: 613-18(Dec. 1966). (In German).

Background information on the construction of the AVR-Experimental Atomic Power Station with the high temperature reactor is given and the design and operation of the installation is described. The main features of high temperature reactors are emphasized and their competitive prospects are discussed and justified. (auth)

17486 SALVETTI REPORTS ON FUTURE NUCLEAR DEVELOPMENTS IN ITALY. Comit. Naz. Energ. Nucl., Notiz., 12: No. 12, 57-62(Dec. 1966). (In Italian).

The Deputy Chairman of C.N.E.N., Prof. Carlo Salvetti, has prepared, for the Advisory Committee on Energy, a report entitled "Nuclear Energy Developments after 1970 and the Indicative Euratom Program." The Report, which was submitted at the Committee meeting held last July 21, discusses the future of nuclear energy in Italy for the purposes of longterm planning. (auth)

17487 OPTIMUM FUEL UTILIZATION IN THE LONG TERM NUCLEAR POWER GENERATING PROGRAM IN JAPAN. Nagashima, Kikusaburo (Sumitomo Atomic Energy Industry Ltd., Japan). Nippon Genshiryoku Gakkaishi, 8: 645-55(Dec. 1966). (In Japanese).

A study on the long term nuclear electric power generating program has been undertaken on the following basis: (1) An overall nuclear electric power generating system is considered in which both fast breeders and thermal reactors would be used. (2) Plutonium to be used in fast breeders should be produced in the system and not purchased from the outside. (3) The time lag between the discharge of plutonium from reactors and availability for fast breeders is taken into consideration. The generating capacities of fast breeders and thermal reactors have been calculated, and the self-sustaining point has been determined to be the time at which the generating power of the system is supplied with fast breeders alone. The total amount of U_3O_8 necessary for the system has also been determined. With the view to fuel economy, the following conclusions have been obtained: (1) It is profitable to use advanced converters as extensively as possible. (2) It is advisable to use fast breeders with as short a doubling time as possible, and as small an inventory as possible. (3) Shortening of the time lag is very effective in reducing the total uranium fuel. (auth)

17488 STABILITY OF MAIN HARMONICS IN A CLOSED-CIRCUIT REACTOR CONSIDERING XENON OSCILLATIONS. Orekhov, Yu. I.; Kuz'menko, B. A. (Inst. of Physics and Power Engineering, Obninsk, USSR). Inzh.-Fiz. Zh., 11: 345-8(Sept. 1966). (In Russian).

The dependence of reactor power on Xe oscillations is examined. The conditions of stability of a closed loop reactor are shown to differ from those for an open-loop reactor and depend on the heat removal from the second loop. Two cases are considered: (1) Heat removal from the second loop is proportional to the output coolant temperature from the second loop; (2) Heat removal from the second loop is constant. A closed-loop reactor becomes more stable as compared to an open-loop reactor. (auth)

17489 ON ASCERTAINING ASYMPTOTIC STABILITY IN THE LARGE OF NUCLEAR POWER REACTORS BY MEANS OF LIAPUNOV'S SECOND METHOD. Schwalm, D. (EURATOM, Ispra, Italy). Nukleonik, 8: 378-83(Sept. 1966).

The analysis of La Salle and Lefschetz is applied to the problem of nuclear power reactor stability. It is shown that in the case of second order temperature feed-back it is at best equivalent to the Lurie–Letov analysis. Finally the relation between the Welton criterion and Liapunov's direct (second) method is discussed. (auth)

17490 ECONOMICS OF NUCLEAR POWER. Lane, James A. (Oak Ridge National Lab., Tenn.). Annu. Rev. Nucl. Sci., 16: 345-78(1966). (ORNL-P-2545).

A previous paper presented an analysis of the outlook for economically competitive nuclear power as it appeared in early 1959. In the seven years since the earlier paper, events have occurred within the nuclear industry which permit a more accurate definition of the course the industry is likely to follow during the next

several decades. A better assessment of the relative competitiveness of nuclear and conventional power and a clearer identification of the role of nuclear power in future energy needs is now possible. Developments that have occurred during the last few years to clarify the nuclear power picture and their meaning relative to the future of nuclear power are reviewed. 38 references. (H.D.R.)

17491 DEVELOPING FAST BREEDERS IN GERMANY. Strauss, S. D. Nucleonics, 25: No. 2, 36-40(Feb. 1967).

Research directed toward fast breeder reactors cooled by steam or Na is reviewed. The goals of the program include design and construction of Na-cooled and water-cooled 300-MW(e) prototype plants, a 1,000 MW(e) Na-cooled demonstration plant, a 1,000 MW(e) steam-cooled demonstration plant, and a radiochemical processing plant for U and Pu fuels. (J.R.D.)

17492 ARE PLANT ENGINEERED SAFEGUARDS RELIABLE? Garrick, B. J.; Gekler, W. C.; Pomrehn, H. P. (Holmes and Narver, Inc., Los Angeles). Contract AT(04-3)-587. Nucleonics, 25: No. 1, 45-9(Jan. 1967).

A review of operating experience at U. S. nuclear power plants is used as a basis for analysis of engineered plant safeguards. It was found that the systems reviewed never failed to respond satisfactorily to unsafe conditions, however, 36 malfunctions were noted which could have altered correct responses in individual scram circuits. Malfunction sources included trip points, relay switches, poor sensor response, and operating errors. No failures resulted in complete impairment because of system redundances. (J.R.D)

17493 HANFORD SAFEGUARD SYSTEM GUARANTEES SHUT-DOWN REACTOR STAYS THAT WAY. Goldstein, Carl. Nucleonics, 25: No. 1, 58-9(Jan. 1967).

Descriptions and discussions are presented concerning a reactor shutdown safing system comprising a neutron-absorbing target contained in a wire or tape so that it can be positioned in reactor core coolant tubes, control-rod thimbles, or other penetrations. An exterior seal at the end of the core penetration is used to show inspectors that the wire or tape has remained in its position between inspections. (J.R.D.)

17494 STEAM CYCLE INFLUENCE ON FAST BREEDER REACTOR DESIGN. Schneider, George A.; Stoker, Donald J. (Atomics International, Canoga Park, Calif.). Nucl. Eng. Design, 4: 352-9(Nov. 1966).

An evaluation has been made of the effect of steam pressure and temperature on the economics of fast breeder reactors. Steam pressures in the range of 1450 to 3500 psi and steam temperatures in the range of 850 to 1000°F were investigated. In considering the effect of steam temperature, consideration must also be given to Na temperatures since different Na temperatures will affect choice of optimum steam temperature. Reactor outlet Na temperatures of 1050 to 1200°F and primary/secondary Na system temperatures differences of 250–400°F were evaluated. All evaluations considered a fuel cycle cost range of 6¢ to 12¢ per 10^6 Btu when capitalizing operation cost differences among the various alternatives. (auth)

17495 TRANSIENT SODIUM BOILING CALCULATIONS. MacFarlane, D. R.; Brittan, R. O. (Argonne National Lab., Ill.). Nucl. Eng. Design, 4: 360-74(Nov. 1966).

Methods and results are presented of a theoretical investigation on sodium expulsion from a reactor core due to boiling, using the basic equations of hydrodynamics and limited to transients which are slow enough so that coolant boiling occurs before the fuel surface or cladding melts. The results of calculations presented for power increase and flow decay transients in a typical oxide fueled fast breeder reactor coolant channel show that: the two-phase coolant mixture is expelled from the exit of the channel at high velocities; the decrease of flow rate in the single-phase portion of the channel is rapid; and the peak pressures generated in the transients studied are not excessively high. (auth)

17496 ANALYSIS OF FLUID FLOW AND HEAT TRANSFER IN A TRIANGULAR ARRAY OF PARALLEL HEAT GENERATING RODS. Nijsing, R.; Gargantini, I.; Eifler, W. (EURATOM, Ispra, Italy). Nucl. Eng. Design, 4: 375-98(Nov. 1966).

Theoretical considerations are presented on fluid flow and heat transfer for axial turbulent flow in a triangular array of parallel heat generating rods. The analysis proposed can be used to evaluate the distribution around the rods of local coolant velocities, local shear stresses, local coolant temperatures, and local heat transfer coefficients. The effect of rod spacing, Reynolds number, and Prandtl number has been investigated for two heat transfer boundary conditions: that of a uniform peripheral heat flux distribution and that of a uniform peripheral surface temperature distribution at the rod surface. (auth)

17497 THE COST OF FUEL IN NUCLEAR POWER PLANTS, IN PARTICULAR IN POWER PLANTS OF THE EDF 4 TYPE. Gaussens, Jacques. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 63, 21-7(Jan.-Feb. 1967). (In French).

The costs resulting from utilization of nuclear fuel in a power plant of the EDF-4 type are defined. The effect of the utilization of the EDF-4 fuel cycle on the economy of the country is considered from the viewpoint of certainty of supply, foreign bills of exchanges, and Pu production. (J.S.R.)

17498 ECONOMIC EXPLOITATION OF NUCLEAR FUELS. Rometsch, R.; Leclercq-Aubreton, Y. (EUROCHEMIC, Mol, Belg.). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 63, 28-31(Jan.-Feb. 1967). (In French).

The proliferation in Europe of light-water-moderated reactors using U enriched up to a maximum of 5% will furnish data for economic evaluation of these reactors. A preliminary study of these data is given. The economic results from reutilization of enriched U and the utilization of Pu are considered. It was concluded that the reprocessing of irradiated fuel elements from light-water reactors will lead to a reduction in fuel cost. (J.S.R.)

17499 ADAPTATION OF THE BOILER INDUSTRY TO THE CONSTRUCTION OF NUCLEAR EXCHANGERS OF THE GRAPHITE-GAS SERIES. EVOLUTION OF THE TECHNIQUES, CONSTRUCTION PROCEDURES, AND CONTROL METHODS FROM 1955 TO THE PRESENT. Fouche, Lucien; Tillequin, Jean. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 62, 38-43 (Nov.-Dec. 1966). (In French).

The evolution in the techniques, construction procedures, and control methods in the construction of nuclear exchangers is outlined from the Marcoule exchangers, to the Chinon exchangers, and the integrated exchangers. Studies on the minimum volume, forced circulation, material reliability, and short-time assembly are considered for the integrated exchangers. (J.S.R.)

17500 EMERGENCY COOLING OF NUCLEAR POWER REACTOR USING NATURAL CIRCULATION OF THE COOLANT. Lebl, Pavel (Power Engineering Inst., Prague). Jad. Energ., 13: 41-53(Feb. 1967). (In Czech).

The possibility of using a natural circulation of the cooling system for reactor cooling following an emergency shut-down is discussed. Such an emergency cooling system does not rely on outside power for gas-blown cooling. The calculations of the natural gas circulation static in the primary loop were applied for the case of emergency reactor cooling with access to gas blowers. A series of problems related to the natural gas circulation in the reactor primary loop are analyzed. Special problems involving preparations for the tests and measurements necessary for the start up of a power plant and particularly experimental emergency reactor shut-down are discussed. Using the primary loop natural gas circulation it is possible to divert 9% of the nominal reactor power at a nominal gas temperature at the reactor outlet and at nominal gas pressure. In emergency reactor cooling with the access of gas blowers and with natural gas circulation in the primary loop, a good balance of the temporary gas temperature dependence in the hot reactor vessel and the hot pipe line section is achieved. Thus, less stress is established in the pipeline wall during the thermal shock which usually takes place in the case of emergency reactor shut down. (tr-auth)

17501 SYMPOSIUM ON AUTOMATIC CONTROL IN ELECTRICITY SUPPLY, 29–31 MARCH 1966 IN MANCHESTER. PART 1. CONTRIBUTIONS. London, The Institution of Electrical Engineers, [1966]. 351p. (CONF-660334–(Pt.1)).

Twenty-nine papers are included in the conference publication. Separate abstracts were prepared for five of these papers. Papers for which no abstracts were prepared are concerned with automatic switching, general aspects of automatic power station control, automatic control of hydro-electric power stations, on-line computers, automatic control of thermal generating units, and automatic turbine controls. (J.R.D.)

For abstracts of individual papers see: 17502–17505 and 17528.

17502 CONTROL CHARACTERISTICS OF THE VARIOUS TYPES OF NUCLEAR PLANTS. Campbell, R. H.; McMillan, R. N. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 229-54 of Automatic Control in Electricity Supply. London, The Institution of Electrical Engineers, 1966.

Control of gas-cooled and water reactors is examined. Effects of coolant, fuel, and fuel cladding on control are discussed. Discussions are included on reactor operation limitations, reactor requirements imposed by incorporation in power grids, fundamentals of reactor control, control of gas-cooled reactors, and control of water reactors. Schematic diagrams of gas-cooled and water-cooled reactors are included. (J.R.D.)

17503 AUTOMATIC CONTROL IN GAS-COOLED-REACTOR NUCLEAR POWER STATIONS. Gow, R. S.; Millard, D. J. pp 255-83 of Automatic Control in Electricity Supply. London, The Institution of Electrical Engineers, 1966.

Information is presented concerning the principles of reactor control, reactor core neutron flux stabilization, design aspects of reactor automatic control systems, control system commissioning and optimization, experience in control of reactor instability, operational uses of automatic reactor control, safety aspects of reactor automatic control, power control in stations using gas-cooled reactors, and future trends in automatic control. (J.R.D.)

17504 ALARM ANALYSIS AND INDICATION AT OLDBURY NUCLEAR POWER STATION. Kay, P. C. M.; Heywood, P. W. pp 295-317 of Automatic Control in Electricity Supply. London, The Institution of Electrical Engineers, 1966.

Design and operation of an Oldbury alarm system is described in which the number of alarm messages which can appear on the cathode ray tube displays as a result of a single basic reactor system fault is reduced by feeding all alarm information to a computer. The computer analyzes the alarm patterns and suppresses those alarms which are intermediate effects in a cause-and-effect chain. (J.R.D.)

17505 CONTROL OF LARGE FAST REACTORS. Thomasson, R. K. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 344-9 of Automatic Control in Electricity Supply. London, The Institution of Electrical Engineers, 1966.

Design bases for these reactors are reviewed. Discussions are included on control characteristics, control philosophy, steam pressure control, reactor outlet temperature control, design changes for once-through boilers, and advanced-feature development. (J.R.D.)

17506 FAST REACTOR TECHNOLOGY: PLANT DESIGN. Yevick, John G. (ed.). Cambridge, Mass. and London, Eng., MIT Press, 1966. 772p. $35.00.

The book is divided into eleven chapters. One specific aspect of fast reactor design is discussed in each chapter. Information is included on coolant properties, structural analysis, heat-transport systems, containment and site criteria, fuel handling, shielding, instrumentation and control, and economics. One chapter is devoted to descriptions of fast reactors. (J.R.D.)

Marine and Portable Power Reactors

17507 (NYO-10741) SPECIFICATION FOR PM TYPE NUCLEAR REACTOR CORES (TYPE 4 DESIGN). (Hittman Associates, Inc., Baltimore, Md.). Dec. 1966. Contract AT(30-1)-3583. 170p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The materials, fabrication, assembly, testing, inspection and quality control specifications for type 4 for PM-1 and PM-3 reactors cores are presented. (J.C.W.)

17508 STUDY ON THE INTEGRATED CONSTRUCTION OF A SHIP REACTOR PLANT. THE PROBLEM OF SHIELDING DESIGN. Tanaka, Yoshihisa (Kawasaki Dockyard Co., Ltd., Japan). FAPIG (Tokyo), No. 39, 248-53(Jan. 1966). (In Japanese).

The integrated construction of a ship reactor plant is investigated from the standpoint of its shield. Minimizations in weight and volume and the resulting reduction in the cost are analytically studied. A multi-layer shield consisting of water and iron layers is the lightest and the smallest in volume for the primary shield for a reactor core. Three to five layers are sufficient in terms of weight for a multi-layer shield. The use of a low-cost shield-layer on the outside is beneficial economically. The conventional heat-exchangers are excluded from the optimum design of a shield. As the reactor power output is increased, the weight of shield per kW is decreased. When a heat exchanger is located outside the pressure vessel, it is possible to reduce the weight of a plant. When ship reactor-plants devoid of fuel-exchange and control systems are developed, the problem of integrated construction may be reduced to the shielding of a reactor core. (NSA of Japan)

17509 NUCLEAR SHIPBOARD OPERATING EXPERIENCES. Smith, W. R. (Babcock and Wilcox Co., Lynchburg, Va.). pp 37-50 of Institute of Nuclear Materials Management Sixth Annual Meeting. Columbus, Ohio, Institute of Nuclear Materials Management, 1965.

The history and shipboard operating experience of the N.S. Savannah Reactor are discussed. Operating experience of the world's first nuclear-powered passenger–cargo ship is summarized. The ship's operation to date has demonstrated that the nuclear power plant is safe, reliable and responsive. Regulatory, legal and organizational problems of nuclear powered ships have been resolved. (F.S.)

Rocket and Space Reactors

Refer also to abstract 16062.

17510 (AGC-3297) SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM. Quarterly Progress Report, July–September 1966. (Aerojet-General Corp., Azusa, Calif.). Nov. 1966. Contract NAS5-417. 256p.

SNAP-8 is a turboelectric, nuclear, space power conversion system using a Hg Rankine cycle. The system incorporates three liquid metal loops. Liquid NaK in a primary loop is heated in a reactor, and, in turn heats Hg in a heat exchanger. The Hg vapor, in the second loop, expands through a turbine; it is then condensed, and pumped back through the boiler. A third loop, also containing NaK, transfers the heat from the Hg to a radiator where it is rejected to space. The fourth loop contains a polyphenyl ether that lubricates the bearings of the main rotating components and provides necessary cooling for the alternator, electric motors, and controls. The development progress is reported on the power conversion system including the turbine-alternator assembly, pump-motor assemblies, boiler, condenser, and electrical controls. Results of system testing during the period are summarized. (auth)

17511 (LA-DC-8516) SUMMARY OF COUPLED KIWI EXPERIENCE. Helmick, Herbert H.; Chezem, Curtis G. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 8p. (CONF-670107-3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

The neutronic stability of a two-core cluster of nuclear rocket engines of the Kiwi and Phoebus I class was confirmed by measurements of transfer functions and pulsed neutron source behavior. Techniques for computing the coupling parameters and power perturbations were verified by static measurements on the coupled system. (M.L.S.)

17512 (N-66-26757) CENTERBODY DIFFUSER STUDY. (Aerojet-General Corp., Sacramento, Calif.). Oct. 1965. Contract SNP-1. 124p. (NASA-CR-75221; RN-S-0243). CFSTI $3.00 cy, $0.65 mn.

In order to determine the feasibility of water-cooled centerbody diffusers for nuclear rocket application, nine different scale model centerbody configurations were fabricated and tested. The models included three nose cone sizes, and for each nose cone size three different cone frustrums were designed; the nose cones varied by the magnitude of their half-angle. Testing was conducted using the pressure blowdown system in series with a large stored energy heater to supply the gaseous nitrogen to the $1/15$ size NERVA II nozzle. For the range tested, nose cone angles and radii seemed to have no noticeable influence on the ejector starting pressure. With the use of a correlation factor of 1.15, the starting pressure ratio can be predicted by means of the conventional normal shock theory. It was proven that a full scale, water-cooled centerbody diffuser can be built. A theoretical investigation of heating rates involving the spherical tip, the cone frustrum, the transition point cone-to-sphere, and the mounting struts of the centerbody for laminar and turbulent flow revealed that the absolute maximum heating rate is located at the sonic point, i.e., a spot on the spherical segment under turbulent flow conditions about 41° from the forward stagnation point. (STAR)

17513 DESIGN STUDY OF A FISSION ELECTRIC CELL REACTOR. Shapiro, Jerome L.; Heindl, Clifford J. (California Inst. of Tech., Pasadena). Nucl. Eng. Design, 4: 345-51(Nov. 1966).

The fission-electric cell-reactor concept involves the direct utilization of the energy of fission fragments by allowing those charged particles to do work against an electric potential. Analyses have been made of the efficiency obtainable indicating that reasonably high efficiency can result for very-thin fuel layers and high voltages. For space applications the restrictions of size and weight must be added to the criticality condition, to assess the feasibility of the system. The analytic techniques used in a design and optimization study of a fission-electric cell reactor are described, and a discussion of the results is presented. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 17465.

17514 (NP-16558) METODIKA RASCHETA STOIMOSTI VODY I ELEKTROENERGII DLYA YADERNYKH OPRESNITEL'NYKH USTANOVOK. (Methodology of Calculating Water

and Power Costs for Nuclear Desalination Plants). Loginov, A. A.; Koryakin, Yu. I.; Chernyaev, B. A.; Zakharov, I. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 1966. 15p. (In Russian). Dep. mn.

Although the Soviet Union is in a relatively favorable position as far as the fresh-water supply is concerned, some of its regions, such as the Eastern and Western Caspian zones, Central Asia and Kazakhstan are far removed from large sources of water. Their rate of industrialization requires a simultaneous supply of electrical energy and fresh water; therefore, the economics involved in the operation of such dual-purpose nuclear plants were examined. The Soviet Beloyarks and Shevchenskii type reactors are best suited for predominantly electric energy generation. To satisfy large demands, fast breeder reactors are recommended. Several cost-accounting methods are currently used, depending whether the electricity generated is considered a secondary product, part of a large generating system, or the plant is supposed to operate as an independent central station. In order to conform to the requirements of the Soviet national economy, an accounting method was developed, allowing the separate determination for fresh-water production and generation of electricity on the basis of a vertical distillation plant, using sea water with a maximum salt content of 120 kg/ton. The specific cost of fresh water depends on the temperature of the heating steam, the temperature drop, and the number of evaporation stages. The effect of the reactor type on the economic indicators was also taken into account. (TTT)

17515 (STI-DOC-10/69) COSTING METHODS FOR NUCLEAR DESALINATION. Technical Reports Series No. 69. (International Atomic Energy Agency, Vienna (Austria)). Nov. 1966. 50p. IAEA; $1.00; Austrian Schillings 26,-; Pound 0.7.1; F Fr 4.90; DM 4,-.

Various methods of calculating the cost of desalted water are reviewed. Distillation is the process considered with special stress on dual-purpose plants. Existing accounting procedures for a detailed breakdown of various desalination plant components are presented. Methods of optimizing the plants and a numerical example are given. (J.C.W.)

17516 (AEC-tr-6629) WATER AND WATER TREATMENT IN NUCLEAR POWER PLANTS. Kot, A. A. Translation of Vodopodgotovka i Vodnyi Rezhim Atomnykh Elektrostantsii, Atomizdat, Moscow, 1964. 317p. (IPST-Cat.-1503). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $19.75 fs, $9.33 mf.

Information on water supply and treatment is summarized. Compositions of water solutions used as reactor coolants are discussed along with questions concerning corrosion of metallic structural materials, scale formation, and deposits in steam superheaters and turbines. Chapters are included on properties of water, boiling mechanisms, characteristics of nuclear processes and nuclear power plants, structural material corrosion, reactions in reactor water loops, deposits in steam systems, chemical desalination of water, steam and water purity, and water testing methods. (J.R.D.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 16581, and 16636.

17517 (CEND-235) POWER BURST FACILITY FUEL ROD PROTOTYPE OUT-OF-PILE THERMAL TESTS. Final Report. Burdg, C. E.; Zuromsky, G.; Koziol, J. J. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Mar. 1965. Contract AT(10-1)-205; Subcontract C-258. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Phillips Petroleum Co., [Idaho Falls, Idaho].

Preparation of sample fuel materials for the test work was aimed at achieving single-phase, fcc solid solutions of UO_2 in CaO-stabilized ZrO_2, with high density. High temperature structural stability of both 57 mole % UO_2 and 67 mole % UO_2 compositions was found to be generally excellent. The macrostructural integrity of the sample pellets was retained up to within 100°C of their melting points, with the exception of some thermal stress cracking at the highest temperature. Small amounts of a second phase were developed at 1300°C, as well as a fine precipitate within the grains. At 2000 and 2350°C there was only the fine precipitate with trace amounts of a metallic material. In all cases, the predominant structure was the as-sintered fcc structure. The secondary materials did not affect the dimensional stability. The melting points were determined to be about 2450°C for the solidus temperature of both the 57 and 67 mole % UO_2 compositions. The liquidus temperature is about 2550°C for the 57 mole % UO_2 composition and 2575°C for the 67 mole % UO_2 composition. Specific heat of the 57 and 67 mole % UO_2 compositions, and more particularly the heat content, was determined at 500 to 2000°C. The values are between those of UO_2 and ZrO_2, approximately in proportion to composition. Thermal conductivity was determined by a radial heat flow method. For 57 mole % UO_2 composition the value was found to be about 0.03 W/cm°C at 800°C, decreasing to about 0.017 W/cm°C at 1700°C, then increasing to 0.035 W/cm°C at 2200°C. For 67 mole % UO_2 composition, the values were 0.022 W/cm°C at 800°C, 0.018 W/cm°C at 1400°C, and 0.035 W/cm°C at 2100°C. The shape of the curves corresponds roughly to that for UO_2, but with a generally lower value. Of particular interest is the sizeable increase in conductivity at higher temperature. Thermal cycling tests, conducted with three different fuel compositions, were performed to simulate, out-of-pile, the thermal gradients and temperatures expected in an operating element. The test results indicate that some fuel densification occurred at the higher temperatures. Thermal stress cracking was pronounced in the fuel, and present in the insulators. (J.R.D.)

17518 (DP-1064) THE HAMMER SYSTEM: HETEROGENEOUS ANALYSIS BY MULTIGROUP METHODS OF EXPONENTIALS AND REACTORS. Suich, J. E.; Honeck, H. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1967. Contract AT(07-2)-1. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The HAMMER system comprises programs for calculations of infinite lattice parameters by multigroup transport theory, and of composite reactor parameters by few-group diffusion theory. Operating procedures for this system of linked reactor physics codes are presented for the HAMMER system and for the auxiliary cross section library codes. (auth)

17519 (IN-1053) A SUMMARY OF DATA FROM THE ATRC EXPERIMENTAL PROGRAM. Henscheid, J. W.; Kaufman, N. C.; Durney, J. L. (Idaho Nuclear Corp., Idaho Falls). Feb. 1967. Contract AT(10-1)-1230. 78p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A summary of the results of the Advanced Test Reactor Critical Facility (ATRC) experimental program relating to the operation of the ATR is presented. Included in the report are startup proceedings, shutdown reactivity in safety rods, kinetic parameter measurements, shim calibrations, excess reactivity measurements, void reactivity effects, experimental reactivity effects, neutron flux and power distribution measurements, and outer shim rotation reversal effects. (J.C.W.)

17520 (KFK-482) EVALUATION OF REACTOR PHYSICS EXPERIMENTS ON THE COUPLED FAST-THERMAL ARGONAUT REACTOR STARK. Barleon, L.; Bayer, A.; Brueckner, Chr.; (and others). (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sept. 1966. 58p. Dep. mn.

STARK is a coupled zero-power reactor consisting of a subcritical fast core driven by a surrounding light-water moderated thermal zone. Four different fast core loadings, containing up to 107 kg ^{235}U, were investigated so far, one of them with a CH_2-mixture to simulate the spectrum of a steam-cooled reactor. A number of experiments were performed to obtain information on the neutron spectrum in the fast zone: spatial distributions of reaction rates were determined by fission chamber and foil techniques, differential neutron spectra were studied by proton-recoil proportional counters, and reactivity worths of samples were measured in the fast core with a square-wave pile oscillator. Also integral parameters of the entire system were obtained by various kinetic methods. The experimental results are compared with one-dimensional diffusion and S_4-calculations using the Russian 26-group cross-section set. The experimental data give no indication of larger deviations from the calculated spectra in the keV- and MeV-region, whereas discrepancies were found in the lower eV-region. The integral reactor parameters (neutron lifetime, critical mass, partition of reactor power between the zones) were found to agree reasonably well with the calculation. (auth)

17521 (KR-114) NEUTRON COUNTING STATISTICS IN NUCLEAR REACTORS. Babala, Dusan (Institutt for Atomenergi, Kjeller (Norway)). Nov. 1966. 99p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The neutron counting statistics of a zero power reactor are treated on the basis of Kolmogorov's theory of branching processes. It is shown that the statistical properties of a sequence of neutron counts, currently used for experimental determination of reactor kinetic parameters, naturally follow from one basic formula. The Kolmogorov formalism also made it possible to explain the results of Rossi-α experiments performed with a certain type of time analyzers. Further, a formula for the count interval distribution was derived and a new experimental method—interval distribution measurement—suggested. The technique was employed for determining the prompt decay constants of the

NORA reactor and compared with other experimental methods. The effects of space- and energy-dependence are numerically illustrated for a reference slab reactor. Both multi-region technique and model analysis were used for computations. It is shown that the fundamental mode can be interpreted in terms of space and energy independent model, if the neutron lifetime is suitably defined. (auth)

17522 (LA–3606) GAMMA-RAY ENERGY DEPOSITION IN THE MOLTEN PLUTONIUM BURNUP EXPERIMENT (MPBE) REACTOR STRUCTURE. Dudziak, Donald J.; Battat, Morris E. (Los Alamos Scientific Lab., N. Mex.). May 1966. Contract W-7405-eng-36. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In order to determine thermal stresses, heat removal requirements, and thermal expansions, the spatial distribution of neutron and gamma-ray energy deposition in a reactor must be known. Such distributions were determined for the Los Alamos Molten Plutonium Burnup Experiment (MPBE), using both Monte Carlo and point kernel integration techniques to calculate γ ray transport. Neutron transport was calculated using both the diffusion theory and S_4 approximations in two dimensions. Preliminary calculations determined the total γ-ray and neutron energy escape from the reactor vessel and, thus, the reactor room heat load from these sources. More detailed calculations provided point values of the absorbed dose in Fe, C, Ni, Ta, and Na at 70 selected spatial points throughout the reactor system. (auth)

17523 (NP–16455) AVANT-PROJET DU REACTEUR DE RECHERCHE HFFS. CALCUL THERMIQUE DU COEUR. 1ERE PARTIE. DONNEES DU CALCUL. 2E PARTIE. RESULTATES DES CALCULS POUR LES BASSES PRESSIONS. (Preliminary Report on the High-Flux Research Reactor. Part 1. Thermal Calculations of the Core. Part 2. Results of Low Pressure Calculations). Fabrega, S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1965. 80p. (In French). (TT–43). Dep. mn.

The data for the thermal calculation of the preliminary project of the HFFS reactor are assembled. The hypotheses are defined, particularly with respect to the hot channel factors and the physical laws used. The results of the thermal calculations for low pressures are given. (tr-auth)

17524 (ORNL–TM–1752) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JULY–SEPTEMBER OF 1966. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Jan. 17, 1967. Contract W-7405-eng-26. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Following the startup program of operating at progressively higher power, the full reactor design power level of 100 MW was reached on September 9, 1966, at the start of cycle 4. The reactor has been operated with no major problems occurring. The approach of routine operation is indicated by the fact that the reactor operated at power levels of 10 MW or above 84.7% of the time this quarter. Major maintenance jobs this quarter consisted of repairing a leaking primary heat-exchanger tube, reinforcing the foundations of the secondary coolant circulating pumps, and slightly modifying the reactor control system. (auth)

17525 (RISO–134) A DESCRIPTION OF THE PILE OSCILLATORS AT DR 1. Christensen, P. Skjerk (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1966. 41p. Dep. mn.

The pile oscillators at DR1 (a homogeneous reactor), together with the results of some measurements performed, are described. Two types of oscillators are in current use: a global and a local oscillator. The global oscillator is used in two positions; in the center and at the edge of the core, in order to be able to separate the absorbing and the scattering properties of a given sample. The local oscillator is situated in the reflector of the reactor, and utilizes an annular B-coated ionization chamber made at Risö. The main parameters of the oscillators are a square wave movement of 70 cm stroke and 30 sec period with a transfer time of 0.5 sec and a flux of some 10^8 n/cm^2/sec at a power of 15 W. These conditions give the least noise, corresponding to the signal from 0.03 mm^2 absorber material (0.01 mg B). The ratio between absorption and moderation signals is 6.3 in the core center and 14.5 in the local oscillator. The epithermal index r is 0.1 at the core center and 0.05 at the local oscillator. (tr-auth)

17526 (RT-ING–(66)–15) DISPOSITIVI DI IRRAGGIAMENTO DI CAMPIONI FISSILI NEL REATTORE ISPRA-1. (Rigs for the Irradiation of Fissile Specimens in the Ispra-1 Reactor). Gerosa, A.; Moretti, S.; Tasselli, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 51p. (In Italian). Dep. mn.

The irradiation facilities used since 1959 in the Ispra-1 Reactor for in-pile experimental studies on fissile materials are described. Safety aspects, loading and running problems are discussed. (auth)

17527 (WAPD-TM–642) EPITHERMAL NEUTRON SPECTRA IN THE MATERIALS TESTING REACTOR. Rothman, A. B.; McGarry, E. D. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT-11-1-GEN-14. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Epithermal neutron spectra between 0.65 and 500 eV have been determined in three reflector locations of the MTR using resonance detectors. Results suggest that effects of crystalline binding in Be on spectra in the range of a few electron volts are similar to those attributable to chemical binding in water. (auth)

17528 INFORMATION GATHERING, PRESENTATION AND USE IN PROTOTYPE NUCLEAR PLANT. McAffer, N. T. C.; Grant, J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 284-94 of Automatic Control in Electricity Supply. London, The Institution of Electrical Engineers, 1966.

Information required to confirm design hypotheses, fix unknowns, and ensure safety in prototype reactors is discussed. Information is included on cost reduction methods for data-gathering systems, applications and results of reliability techniques, and uses of data processing equipment. (J.R.D.)

17529 SURFACE SOURCE METHOD FOR CALCULATING RADIATION PENETRATION THROUGH SECONDARY SHIELDS. Kitazume, Mitsuyuki (Hitachi Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 8: 636-42(Dec. 1966). (In Japanese).

A method for calculating the radiation dose rate on the surface of the secondary shield of a reactor from a known radiation distribution on the surface of the primary shield is presented for three kinds of primary shield geometries—cylinder, cube, and sphere. This method was used to calculate the dose rate distribution around the HTR (Hitachi Training Reactor), and compared with the measured values. (auth)

17530 ON A PROBLEM CONCERNING THE PHYSICS OF LOCAL PILE OSCILLATORS. Sellerio, A. (Univ., Palermo, Italy); Greco, G.; Oliveri, E.; Sinagra, E.; Spitale, M. C. Nukleonik, 8: 406-8(Sept. 1966).

In working with a local pile oscillator in a tangential channel of a small reactor, it was found to be difficult to measure thermal neutron absorption cross sections in the presence of a high epithermal flux. A method is formulated to allow the measurements to be made by the cadmium difference method employing a small oscillating sample. Results obtained on a number of samples employing the new method are tabulated and discussed. (H.D.R.)

17531 SHIELDING FOR THE REACTOR RAPSODIE. Chwetzoff, W.; Dubois, F.; Poitevin, P. Bull. Inform. Sci. Tech. (Paris), No. 110, 3-29(Dec. 1966). (In French).

The reactor Rapsodie 4 is shielded laterally by concrete which must be able to support working temperatures of the order of 200°C. It was developed on the basis of tests carried out on samples at room temperature, at high temperature, and finally under irradiation. Tests were performed on a mock-up representing a lateral shielding element of Rapsodie, to determine the possibilities of using fresh concrete and to verify that the concrete behaves satisfactorily after hardening. Special precautions were taken in the manufacture, the placing in position and the hardening of this concrete in order to keep its temperature at 60°C during the time necessary for the cement to set. (auth)

17532 SWIMMING-POOL TYPE NUCLEAR REACTOR FUEL COOLING. de Kervenoael, O.; Virnot, A. (to Indatom S.A.R.L.). Canadian Patent 747,485. Nov. 29, 1966. Priority date Jan. 7, 1960, France.

To increase the power of a pool-type reactor, an improved cooling system is proposed. A small pump circulates water from the pool in opposite directions inside each autonomous envelope containing a fuel element. Such cooling water is then returned to the pool after passage through a decontamination device and ion exchange resins. All the above equipment is immersed in the pool adjacent to the fuel elements. The pool depth required for safety may be decreased by surmounting each fuel element with a lead brick. A damaged fuel element does not contaminate all the pool water; only that in a local area. Fission products can be restrained by a flow time through the auxiliary circuit of about ten minutes. (F.S.A.)

Production Reactors

17533 (WAPD-TM–615) RELATIVE REACTION RATES IN SEED-BLANKET SLAB ASSEMBLIES WITH HYDROGEN-TO-THORIUM RATIOS OF 0.51, 1.55, AND 5.1. Johnson, P. G.; Emert, C. J.; Korsmeyer, J. D.; Milani, S.; Mitchell, J. A.; Serenka, R. G.; Weiss, S. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-Gen-14. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Lattice parameters were measured and calculated in ThO_2 blanket regions as a function of distance from seed regions in three one-dimensional seed-blanket slab cores. These cores contained ThO_2 blankets with H/Th atom ratios of 0.51, 1.55, and 5.1 to cover a wide range of blanket rod spacings of interest in power reactor design. The blanket regions were relatively narrow so that lattice parameter measurements were made in a nonasymptotic neutron spectrum. This situation is typical in seed-blanket power reactors where highly enriched seeds are separated by relatively narrow blanket regions. These experiments were performed to test the ability of the calculational model and the nuclear data to predict blanket parameters in an environment representative of a large seed-blanket reactor. (auth)

Reactor Components, Fuels and Accessories

Refer also to abstracts 16561, 16592, and 16666.

17534 (EUR-3152.e) EXPERIMENTAL INVESTIGATION OF THE ^{238}U RESONANCE NEUTRON CAPTURE INTEGRAL OF URANIUM CARBIDE CLUSTERED FUEL ELEMENTS CONTAINING MODERATING COOLANTS. Boeuf, A.; Tassan, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 16, 1966. 82p. Dep. mn.

A study of the effective resonance integral for ^{238}U capture of U and UC elements with several geometries was undertaken at CCR Ispra in 1963. The last phases of this investigation, i.e. the measurement of the ^{238}U effective resonance integral of 4-rod and 7-rod UC clustered fuel elements, of varying geometry and containing several cooling media at room temperature are described. Information on the experimental techniques used is included. (auth)

17535 (EUR-3155.e) FUEL-CLAD CONTACT CONDUCTANCE. Arrighi, J.; Mustacchi, C.; Zanella, S. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 16, 1966. 116p. Dep. mn.

An investigation was made of clad-pellet contact conductance for reactor fuel elements. Standard plane geometry correlations were shown to be unreliable whereas suitable cylindrical geometry measurements both in- and out-of-pile were accounted for by theoretical and experimental analysis. Both the gas conduction and the metal-to-metal conduction components were studied using as parameters the elastic and plastic properties of the materials in contact, contact pressure, surface finish, and nature of the fluid in the gap. Particular care was given to the case of SAP-clad UC. (auth)

17536 (EURAEC-1742) USE OF PLUTONIUM AS A FUEL IN NUCLEAR REACTORS. Quarterly Report No. 10, April 1-June 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire, Brussels). Sept. 1966. Contract 001-64-1-TRUB. 81p. (BN-6609-30; EUR-3302). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Two procedures for fusion of mixed fuel powders using high-frequency currents were tested. They are characterized by the direction in which the load moves. The conditions for welding plugs to thin cans (0.25 mm Incoloy) were defined for swaged-type rods. The shape of the rod plugs for irradiation tests in capsules was improved. During vibration compacting of fuel rods for neutron tests, analysis of the gamma activity showed similar distribution whether measured on a single generator or on four. An automatic counter of residual gamma contamination was installed. Initial results appear to agree with previous measurements. The reprocessing of liquid wastes by dry evaporation, followed by low temperature roasting, was found satisfactory. At the present status of research, 510 W/cm is adopted as the mean power generated in the middle of the central rod irradiated in the second series of irradiation tests on the BR-2 reactor hydraulic conveyor. On the basis of quantimetric measurements, the mean power was estimated at 770 W/cm in the middle of the central rod irradiated in the third set of BR reactor tests. The second boiling water capsule was unloaded following the detection of a leak. Development of the determination of ^{148}Nd as an indicator of the burn-up ratio was started. The evolution of the isotopic composition induced by fission neutron capture was examined theoretically. The Cadilhac code used for neutron spectra in heterogeneous media was adapted to the two specific cases of the Spectrox and Amoyal-Benoist (ABH) methods. The experimental program of sub-critical approximations on VENUS/Vulcain fuel was clarified. The purpose of the last two stages of the program is to measure the effect of poisoning in the reflector and the core respectively. A standard isotopic composition representative of those provided for Pu recycling purposes, and optimization methods were developed in Pu recycling studies. (J.R.D.)

17537 (ORNL-TM-1110) PRELIMINARY STUDIES OF THE PREPARATION OF UO_2 MICROSPHERES BY A SOL-GEL TECHNIQUE. Wymer, R. G. (comp.) (Oak Ridge National Lab., Tenn.). Apr. 19, 1965. Contract W-7405-eng-26. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Laboratory methods are described for production of uranium oxide microspheres from UO_2 sols. Process details and analyses of products at various steps are reported. (P.G.C.)

17538 (WAPD-TM-581) FABRICATION OF FUEL PELLETS FROM SOL-GEL POWDERS. Crain, H. H.; Hutchison, C. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1966. Contract AT(11-1)-GEN-14. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A feasibility investigation was conducted on the fabrication of fuel pellets by the press-and-sinter technique from sol-gel oxide powders. Two compositions, 8 wt % UO_2-ThO_2 and 30 wt % UO_2-ZrO_2, were investigated. Preparation of the material, fabrication of the pellets, and inspection and evaluation are described. Fabrication of high-density pellets from the 8 wt % UO_2-ThO_2 sol-gel was moderately successful. The material was extremely difficult to compact and would require further development. Greater than 94% theoretical density was achieved with the 30 wt % UO_2-ZrO_2 only by sintering at 1750°C or by using a double-sinter process. Additional work on formation of this latter sol-gel material would be necessary. (auth)

17539 (WAPD-TM-593) EXAMINATION OF A FAILED ROD OPERATING WITH MOLTEN UO_2-ZrO_2-CaO FUEL. Rubin, B. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec. 1966. Contract AT(11-1)-GEN-14. 80p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A 0.250-inch diameter Zircaloy-4 sheathed fuel rod containing dished-end pellets of ZrO_2 + 6.1 wt % CaO + 33.2 wt % UO_2 operated at high heat fluxes and with approximately half of the fuel volume in the molten state. It is postulated that contact between molten fuel and the tubing resulted in burn-through and rod failure. The rod operated at full power for 25 minutes after failure, which was sufficient time for intensive hydriding of the cladding to occur. (auth)

17540 EXPERIMENTS ON INITIAL TRAVEL OF SAFETY ROD. Ionaitis, R. R.; Kolganova, L. I. At. Energ. (USSR), 22: 51-4(Jan. 1967). (In Russian).

In order to collect data on the travel of safety rods during scramming, a test stand including the beamhole, shock absorber and hydraulic system was built. A special valve was included, making it possible to vary the dropping conditions. It was found that the velocity of the rod varies during the rapid insertion; oscillations were noted; they became larger as the rod travel velocity increased. Removal of air from the channel reduced the amplitude of the oscillations. The results allowed derivation of a number of relatively simple, but still sufficiently precise, formulas concerning the laws controlling the dropping of scram rods. In order to express the relationship in a dimensionless form, it was assumed that the parameters, such as the rod travel velocity, time and distance, correspond to those of a freely falling body. (TTT)

17541 STUDY OF THE COMPONENTS OF A CONCRETE TO BE USED AT HIGH TEMPERATURE IN A PRESTRESSED REACTOR PRESSURE VESSEL. Foucault, M.; Houyez, A. Bull. Inform. Sci. Tech. (Paris), No. 110, 67-85(Dec. 1966). (In French).

An important aspect of the research conducted by the E.D.F. on the use of concrete at high temperature, for an eventual application to the pre-stressed concrete pressure vessels of Nuclear Centres is the choice of components: cement, sand, and aggregate. A study, using nine binding agents, of the development of the main hydrated phases of portland cements and slag cements at 20 to 500°C shows a certain correlation between the intensity of crystal transformation and the reduction in mechanical resistance of I.S.O. mortars, showing an advantage for binders poor in Al or rich in silicates, such as cements of high slag content. Following a selection study performed on sixteen different concrete compositions treated at 150°C and 300°C blast furnace slag seems to be a very interesting aggregate, whereas the mechanical properties of basalt concretes are very much affected by temperature, porphyry, and metamorphic limestone occupying a position between the two. These studies, from which no conclusion can be reached regarding the temperature admissible for a concrete on which heavy demands are made, they show, however, that the destructive tests normally used as criteria of quality are now inadequate to define the behavior of a concrete at high temperature. (auth)

17542 MEASUREMENT OF FAST NEUTRON DOSE ALBEDO FOR VARIOUS BARRIERS. Trykov, L. A.; Goryachev, I. V.; Kukhtevich, V. I. At. Energ. (USSR), 21: 246-54(Oct. 1966). (In Russian).

A single-crystal scintillation spectrometer was used for measuring energy distribution of fast neutrons reflected from Fe, soil, H_2O, and polyethylene at various angles of incidence to the surface of the investigated media. The fast neutron dose Albedo was measured as a function of Fe barrier thickness. The results of measurements are correlated to published data. (tr-auth)

17543 IRRADIATION EXPERIMENTS ON CONCRETES. Rappeneau, J.; Lagorio, M. F.; Gilbert, J.; Piron, P. Bull. Inform. Sci. Tech. (Paris), No. 110, 31-48(Dec. 1966). (In French).

The tendency in nuclear reactor development at present is to bring the concrete shielding closer to the reactor core, thus subjecting it to increasingly higher irradiation doses and working temperatures. It is therefore necessary to know how concrete behaves under the effects of neutron radiations and heat. A review is presented of the important properties required in special concretes and the methods used to study them and the hot cell in which irradiated samples are measured is described. The irradiation devices are also described along with an irradiation experiment. The results of the first experiments are given; these concern the variations in physical and mechanical characteristics of the types of concrete studied. (auth)

17544 COMPACTED SAND SHIELDING. Lenfant, M.; Lagorio, M. F. Bull. Inform. Sci. Tech. (Paris), No. 110, 49-65 (Dec. 1966). (In French).

The research carried out to select materials suitable for use in movable shielding of dry-compacted sand is described, and the methods used to develop such shielding are examined (problems raised by granulometry and variations in density as a function of B and H content). The possibilities of segregation and the conditions for use and for mounting on the site were studied in the laboratory and on a mock-up. The thermal conductivity of non-compacted and compacted sands, at temperature to 200°C, was also measured. The first observation on the behavior of the sands under the effects of radiation are given. Several types of mixtures of sands with varying densities (1.8 to 4.9), suitable for use as nγ shielding, are described. Amongst these mixtures, two or three have been chosen for the production of certain biological shieldings in the reactor Rapsodie. (auth)

17545 REACTOR-CONTROL DEVICE WITH CONTROL ELEMENTS WOUND AND UNWOUND. Kitano, Akihiko (to Tokyo Electric Power Co., Inc.). Japanese Patent 1966-2240. Feb. 15, 1966. Filed June 21, 1965.

In the reactor control device, control rods with control elements wound and unwound are employed. By means of the thin, wide and long control elements, which can be wound and unwound in the controlled case, the neutron-absorbing area can be varied freely. In and through the control rod case is installed a rotary shaft. One end of each flexible control element long plate is fixed onto this shaft, and the other end (or the plate itself) can be drawn out of the case through the slit cut in the case wall. The control element plates can be taken out or put back in the control rod case. (NSA of Japan)

17546 PROBLEM OF ECCENTRICALLY MOUNTED FUEL PELLETS. Brook, A. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Design, 4: 429 31(Nov. 1966).

The problem of calculating the effects of clearances between a fuel pellet or element and its can on the temperature and heat flux distribution in reactor fuel elements is discussed. Typical temperature distributions in eccentrically mounted oxide fuel and cans and the dependence of heat flux variation on fuel pin size are presented. (H.D.R.)

17547 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Seltrop, Jonas Leonard. British Patent 1,056,246. Jan. 25, 1967. Priority date Feb. 6, 1963, Sweden.

Design of a reactor is described having high thermal performance with provisions for high burnup, easy exchange of fuel, and high specific heat related to reactor volume. The design is concerned with heterogeneous reactors in which liquid fuel is contained in spherical cases that float a liquid metal coolant. The fuel spheres remain in the core tank except during refueling. Specifications and drawings are included. (J.R.D.)

17548 METHOD FOR FABRICATION OF A REACTOR FUEL ROD. Komiya, Takajiro (to Hitachi, Ltd.). Japanese Patent 1966-6438. Apr. 8, 1966. Filed Apr. 2, 1963.

A closed-end cladding tube is filled with fuel pellets and a sealed He gas container made of a low melting material such as a Pb–Bi, Pb–Sn, Sn–Zn alloy, or polyethylene is inserted and the tube closed. The cladding tube is heated externally and the gas container is melted releasing the helium to fill the tube. (P.G.C.)

GENERAL

17549 (ANL–7238) ARGONNE NATIONAL LABORATORY PUBLICATIONS, JULY 1, 1965–JUNE 30, 1966. (Argonne National Lab., Ill.). Aug. 1966. Contract W-31-109-eng-38. 368p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A bibliography is presented of scientific and technical accounts originated at Argonne and published during fiscal year 1966 (July 1, 1965 through June 30, 1966). It includes items published as journal articles, technical reports, books, etc., all of which were made available to the public. (B.G.D.)

17550 (ANL–7280) APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1965–JUNE 30, 1966. (Argonne National Lab., Ill.). Contract W-31-109-eng-36. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary is presented of computer programs that were completed during the period. Also presented are summaries of activities in programming research and development, numerical and mathematical analysis, computer utilization in divisional research, computer engineering and computer systems, Argonne code center, and digital computer operations. Listings are included of publications, papers, seminars, and symposia. (L.B.S.)

17551 (DP–929(Suppl.3)) PUBLICATIONS, 1966. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1967. Contract AT(07-2)-1. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of research and development reports, journal articles, contributions to books, and other items published in 1966 by Du Pont is presented. (B.G.D.)

17552 (ECOM–01304-6) CRYSTAL CHEMISTRY STUDIES. Quarterly Report No. 6, August 14, 1966–November 13, 1966. Roy, Rustum; McCarthy, G. J.; Muller, O.; White, W. B. (Pennsylvania State Univ., University Park. Materials Research Lab.). Feb. 1967. Contract DA-28-043-AMC-01304(E). 11p.

Additional data have been obtained on the lanthanide–rhenium compounds and the space group of the Er_2ReO_5 type compound has now been determined as C222 (D_2^1). Work on the divalent oxide–Cr_2O_3–O system at high oxygen pressure has continued. Work has started on the system MnO_2–CrO_2. Investigations have been made on the Eu_2O_3–TiO_2, Eu_2O_3–Ti_2O_3, and EuO–TiO joins in the Eu–Ti–O system. The A-phase has been identified as a monoclinic Eu_2TiO_5. $EuTiO_3$ is shown to have an extremely wide range of stability and is the only Eu^{++} compound in much of the system. The join EuO–TiO is shown not to be binary and compositions along this join dissociate into $EuTiO_3$ and a new oxygen-rich metal phase. (auth)

17553 (LA–3640) SIMULATION OF THE SEL–810A COMPUTER ON MANIAC II (SELMA). Metropolis, N.; Pasta, John R.; Fraser, Malcolm (Los Alamos Scientific Lab., N. Mex.). Nov. 1966. Contract W-7405-eng-36. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The SEL-810A computer was simulated on MANIAC II; MADCAP was used as the programming language. The exercise has several objectives: a detailed knowledge of the logical structure of the SEL-810A and the preparation of programs would be possible; the suitability of MADCAP could be examined for this type of application. The two-pass assembler provided for the SEL computer was tested, and errors in the original versions were detected and corrected. An account is given of other experience. (auth)

17554 (NP–16579) EIGHTH REPORT ON THE ACTIVITIES OF THE AGENCY. (European Nuclear Energy Agency, Paris (France)). Dec. 1966. 110p. Dep. mn.

Progress in the functioning of ENEA's three major joint undertakings, Dragon, Halden, and Eurochemic, is reported along with activities of the Food Irradiation Research Programs, the Computer Program Library, and the Nuclear Data Compilation Center. (M.C.G.)

17555 (ORNL–3911) OAK RIDGE NATIONAL LABORATORY STATUS AND PROGRESS REPORT, DECEMBER 1965. (Oak Ridge National Lab., Tenn.). Jan. 6, 1966. Contract W-7405-eng-26. 57p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the unclassified portion of the Laboratory's work. Topics covered include: the gas-cooled reactor program, reactor fuels and materials, fundamental heat transfer and fluid dynamics, power-reactor fuel processing, fuel-cycle studies, molten-salt reactor program, nuclear safety, radioactive waste disposal, physics and mathematics, chemistry, transuranium-element processing, metallurgy and materials, controlled thermonuclear research, terrestrial and freshwater ecology, health physics, radiation instrumentation, training and education, and isotope development. (M.C.G.)

17556 (SC–DC–67-1305) PROCEEDINGS OF NUCLEAR CRITICALITY SAFETY, DECEMBER 13–15, 1966, LAS VEGAS, NEVADA. Lumpkin, C. K. (ed.) (Sandia Corp., Albuquerque, N. Mex.). Contract AT(29-1)-789. 270p. (CONF-661206). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Summaries of papers concerning criticality and nuclear safety are presented. Discussions are included on criticality safety in power production and in industries using nuclear technology. Discussions are also included on criticality research, criticality data centers, calculation methods, criticality aspects of nuclear processing and fabrication plants, storage and transfer of radioactive materials, nuclear accidents, and nuclear engineering education. The papers are primarily of U.S. origin; however, papers concerning nuclear safety in France, Japan, and U.K. are included. (J.R.D.)

17557 (SC–RR–66-127) COMPUTERIZED NUMERICAL INTEGRATION. Kitzinger, D. G. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer subroutine was written which efficiently handles a large class of integrations. Most functions which can be expressed by combinations of Fortran statements can be integrated. Because the accuracy of the integration can be specified, costly overaccuracy in calculations is prevented. Singularities within the interval of integration are approached optimumly. Double and triple integrals with complicated limits of integration are within the scope of the computer technique. (B.G.D.)

17558 (TID–4552(Rev.4)) SUBJECT SCOPE OF NUCLEAR SCIENCE ABSTRACTS. Volume 21, Number 5, Abstracts 5742–8186. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Mar. 15, 1967. 20p. Dep. DTI Extension Free.

The subject scope of Nuclear Science Abstracts, which defines the subject matter of the literature covered, is presented. Ten major fields are identified with subcategories under each of these fields. The extent of interest in the chemical elements is contained in a separate section following notes on the general subject scope. (B.G.D.)

17559 (WAPD-T–1975) EXPERIENCES IN PRODUCING A MODULAR COMPUTER PROGRAM. Bohl, H. Jr.; Marlowe, O. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 19p. (CONF-670205–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Westinghouse Software Symposium, Pittsburgh, Pa.

Development of the modular computer program, PAX, was influenced by the past history of the individual programs which made up the modules, by the need to make it useful even before completion, by its inherent size and complexity, by the impending computer replacement, and by the need for communication in the areas of documentation and training. (auth)

17560 ANNUAL REVIEW OF NUCLEAR SCIENCE. Segre, Emilio; Friedlander, Gerhart; Noyes, H. Pierre (eds.). Annu. Rev. Nucl. Sci., 16: 1-671(1966).

Developments in the field of nuclear science are discussed in 16 review papers. Separate abstracts were prepared for each of the reviews. (H.D.R.)

For abstracts of individual papers see: 16800, 16864, 17091–17093, 17185, 17186, 17243, 17278, 17372, 17411–17415, and 17490.

17561 MAJOR ACTIVITIES IN THE ATOMIC ENERGY PROGRAMS, JANUARY–DECEMBER 1966. Washington, D. C., Atomic Energy Commission, 1967. 510p. $1.75. GPO.

The major activities in the atomic energy programs for January through December 1966, of the U.S.A.E.C. are described. Topics included are licensing and regulating the atom, reactor and other nuclear facility licensing, regulation of radioactive materials, source and special nuclear materials, nuclear defense effort, naval propulsion reactors, reactor development and technology, space nuclear systems, isotopic heat and power applications, isotopic radiation development, Plowshare program, international cooperation activities, research facilities and projects, nuclear education and training, informational activities, operational safety, industrial participation aspects, and administrative and management matters. (B.G.D.)